SCHOOL OF CIVIL ENGINEERING

JOINT HIGHWAY RESEARCH PROJECT

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ENGINEERING SOILS MAP OF WARRICK COUNTY, INDIANA

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ENGINEERING SOILS MAP OF WARRICK COUNTY, INDIANA

TO: H. L. Michael, Director
Joint Highway Research Project

October 23, 1979

FROM: P. T. Yeh, Research Engineer
Joint Highway Research Project

File: 1-5-2-62

The attached report, entitled "Engineering Soils Map of Warrick County, Indiana", completes a portion of the project concerned with development of a county engineering soils map of the State of Indiana. This is the sixty-second report of the series. The report was prepared by Dr. P. T. Yeh, Research Engineer, Joint Highway Research Project.

The soils mapping of Warrick County was done primarily by airphoto interpretation. Some test data along Interstate 64, SR 662, SR 61, SR 66 and SR 62 and US 460 are included in the report. Generalized soil profiles of the major soil from each land form are presented on the engineering soils map. An ozalid print of the Engineering Soils Map of Warrick County is included in the report.

Respectfully submitted,

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Final Report

ENGINEERING SOILS MAP OF WARRICK COUNTY, INDIANA

by

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All 1940 airphotos used in connection with the preparation of this report automatically carried the following credit line: photographed for Commodity Stabilization Service, Performance and Aerial Photography Division, United States Department of Agriculture.

ENGINEERING SOILS MAP OF WARRICK COUNTY, INDIANA

Introduction

The engineering soils map of Warrick County, Indiana which accompanies this report was done primarily by airphoto interpretation. The aerial photographs used in this study, having an approximate scale of 1:20,000 were taken in August 1940 for the United States Department of Agriculture and were purchased from that agency. A recent set of photography with a scale of 1:24,000 taken in September 1977 and furnished by the Indiana State Highway Commission were used to map the recent man-made features.

Aerial photographic interpretation of land forms, parent materials and engineering soils of this county was accomplished in accordance with accepted principles of observation of inference (1)*.

A field trip was made to the area for the purposes of resolving ambiguous details and correlating aerial photographic patterns with soil texture. Standard symbols developed by the staff of the Airphoto Interpretation Laboratory, School of Civil Engineering, Purdue University, were employed to delineate land forms, parent materials and soil textures. The text of this report largely represents an effort to overcome the limitation imposed by adherence to a standard symbolism and map presentation.

No soil samples were collected and tested by the staff of the Joint Highway Research Project but general soil profiles were developed and are shown on the soil map. The soil profiles were compiled from the agricultural literature and from the boring data of roadway soil surveys along I-64, SR 662, SR 61, SR 66, and SR 62 and U.S. 460. These data were supplied by the Indiana State Highway Commission. Liberal reference was made to the "Formation, Distribution and Engineering Characteristic of Soils" (2).

Description of the Area

General

Warrick County is located in the southwestern part of Indiana. Boonville, the county seat is located near the geometric center of the county. The county is irregular in shape because part of the eastern and the southern boundaries

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*Numbers in parentheses indicate reference in the Bibliography.

follow the courses of Little Pigeon Creek and the Ohio River respectively. The county is bounded on the east by Spencer County on the north by Gibson, Pike and Dubois Counties and to the west by Vanderburgh County (Figure 1).

Warrick County has an area of 391 square miles or 250,240 acres (1011.3 sq. km) (3). According to the 1974 Census of Agriculture about 50.7% of Warrick County or 100,331 acres (518 sq. km) was farm land and about 4.9% of the county or 12,263 acres (49.6 sq. km) was wood land (3). The wood lands were generally confined to the sandstone and shale region particularly along the steep bluff of gullies and streams and along the swampy Pigeon Creek in the northwestern portion of the county as shown in Figure 2. Warrick County had a population of 27,972 in 1970 and 5,736 resided in Boonville as reported in the Census (4).

Drainage Features

Most of Warrick County lies in the Minor Ohio River drainage basin of the state. Only a small area (about five square miles or 13 sq. km) in the north-central part is in the Patoka River basin.

The eastern half of Warrick County is drained by the Little Pigeon Creek and its tributaries. Most of the tributaries are in a southerly direction especially the Pokeberry Creek in the east. Coles Creek with Barren Fork and Otter Creek are the other major tributaries of Little Pigeon Creek. Rock control is clearly evident in the lower course of these tributaries and in portions of Little Pigeon Creek (see Figure 3).

The western half of the county is drained by Cypress Creek and Pigeon Creek. Again, the control by bedrock in the lower reach can be clearly observed on the drainage map. The head water streams of Pigeon Creek seem to have been affected by glaciation. Big Creek, the northwesterly flowing tributary of Pigeon Creek, makes a 90 degree turn in Gibson County and empties its water into Pigeon Creek in a southwesterly direction a short distance from the county border. Two small tributaries in the southwestern portion of the county are flowing away from the Ohio River in a northerly course into Pigeon Creek. The waters of these tributaries eventually reach the Ohio River in Vanderburgh County.

Streams in the north-central part, north of Scalesville, where a high ridge is lcoated drain in nearly all directions. This phenomenon can be observed also locally at the knobs south of Elberfeld and northeast of Mellersburg.

Drainage patterns are fine-textured in the dissected uplands. Extensive man-made ditch systems are developed in the lacustrine plain and the aggraded valleys. Ditches can be detected by the straight alignment of the streams on the drainage map (Figure 3). Some drainage changes have been affected by the dredging of

FIG. I LOCATION MAP OF WARRICK COUNTY

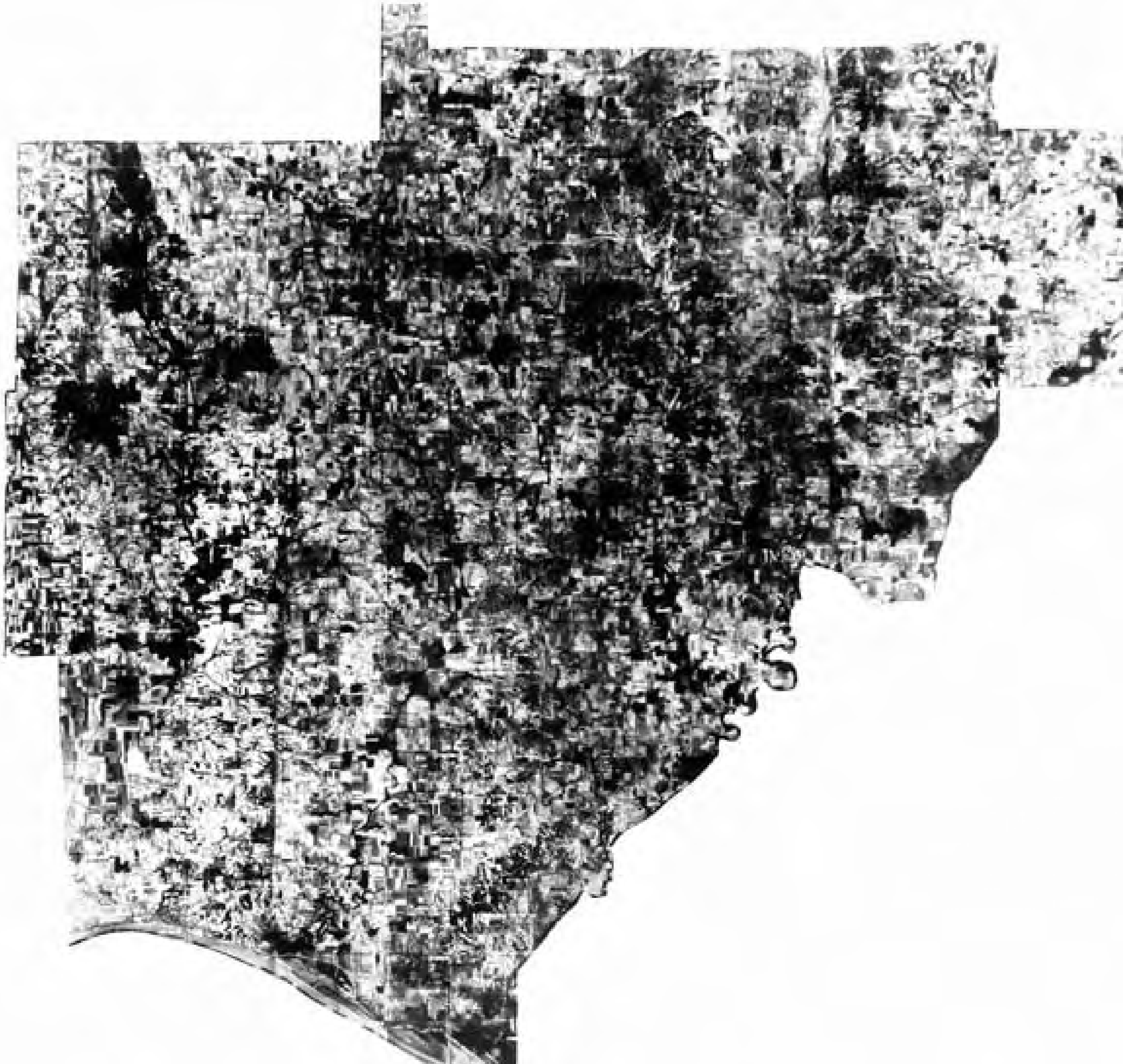

FIG. 2. AIRPHOTO MOSAIC OF WARRICK COUNTY, INDIANA

FROM 1940 INDEX MAP

FIG 3

DRAINAGE MAP

WARRICK COUNTY

INDIANA

certain streams and the operation of strip minings. The abandoned Wabash and Erie Canal somewhat parallels Pigeon Creek from near Rosebud to a point about three miles (4.8 km) north of Millersburg where it joins Pigeon Creek.

There are no natural lakes in Warrick County. However, water-filled strip mine pits and ponds of various origins are scattered throughout the county.

Climate

The climate of Warrick County is continental, humid and temperate. The warm humid summers and moderately cold winters are characterized by frequent sudden change of temperature. Since no Climatological data is recorded in this county, the data recorded in Evansville of Vanderburgh may be used as reference for Warrick County.

The mean and extreme temperature and precipitation of Evansville is listed in Table 1.

Physiography

Warrick County lies wholly in the Wabash Lowland province of the state (Figure 4). With respect to the physiographical situation in the United States, the county lies wholly in the Aggraded Valley section of the Interior Low Plateau province (5).

The Wabash Lowland in Warrick County is characterized by large areas of alluvial and lacustrine deposits surrounding bedrock hills. The evidence of filled in or aggraded valleys is readily observed on the aerial photographs.

Topography

The topography of Warrick County is of great variety. The most outstanding feature is the dissected upland in the north central part of the county. These uneven hills and ridges are the results of the severe erosion of a peneplain. Knobs with an altitude greater than 650 feet (198 m) above sea level are scattered along this massive ridge (Figure 5). Local relief from 100 to 150 feet (30 to 45 m) is quite common in this highly dissected region. The highest elevation of Warrick County is found on Dyson Knob located just north of Lynnville in sec. 34, T3S, R8W. It reaches a height of 658 feet (200 m) above sea level. Two isolated knobs, standing high above the surrounding lowlands, are found in the northwestern quarter of the county. These are the remnant of the interbedded sandstone-shale plain to the northeast. The Little Ditney Hill reaches 570 feet (173 m) and is located in sec. 5, T5S, R9W. The Big Ditney Hill, more than 590 feet (180 m) above sea level, is located in sec. 35, T4S, R9W. The maximum

Table 1. Normal and Extreme Monthly Temperature and Precipitation of Evansville, Vanderburgh County

	Temperature			Precipitation			
Month	Mean °F	Absolute Maximum °F	Absolute Minimum °F	Mean Inches	Driest Year (1930)	Wettest Year (1882)	Average Snowfall
January	32.6	76	-21	3.40	6.20	5.95	3.5
February	35.9	79	-23	3.27	3.12	14.62	3.5
March	44.3	87	- 9	4.69	1.97	4.72	2.9
April	56.7	92	24	4.06	1.10	4.17	0.4
May	65.7	98	28	4.38	1.02	8.45	0
June	74.7	106	41	3.57	2.28	5.25	0
July	77.8	109	47	3.77	1.23	6.05	0
August	76.2	105	46	2.95	1.29	6.70	0
September	69.1	107	31	2.80	3.39	3.30	0
October	58.2	97	21	2.52	1.31	2.25	T
November	44.9	83	- 3	3.17	1.00	3.65	0.8
December	35.3	75	-10	3.30	1.69	5.50	2.2
Year	56.0	109	-23	41.88	25.60	70.61	13.3

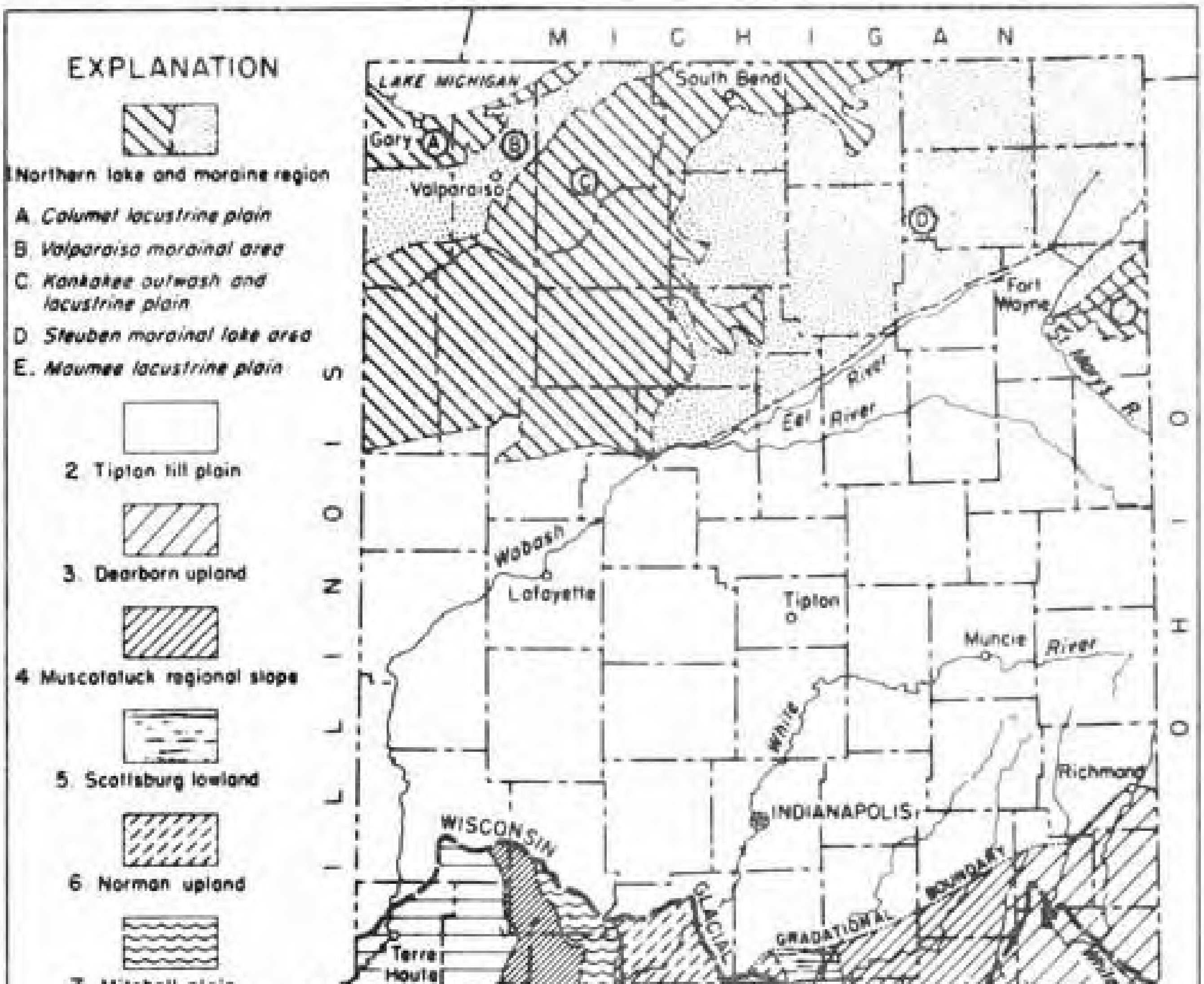

Figure 4 Map of Indiana showing regional physiographic units based on present topography. Modified from Malott

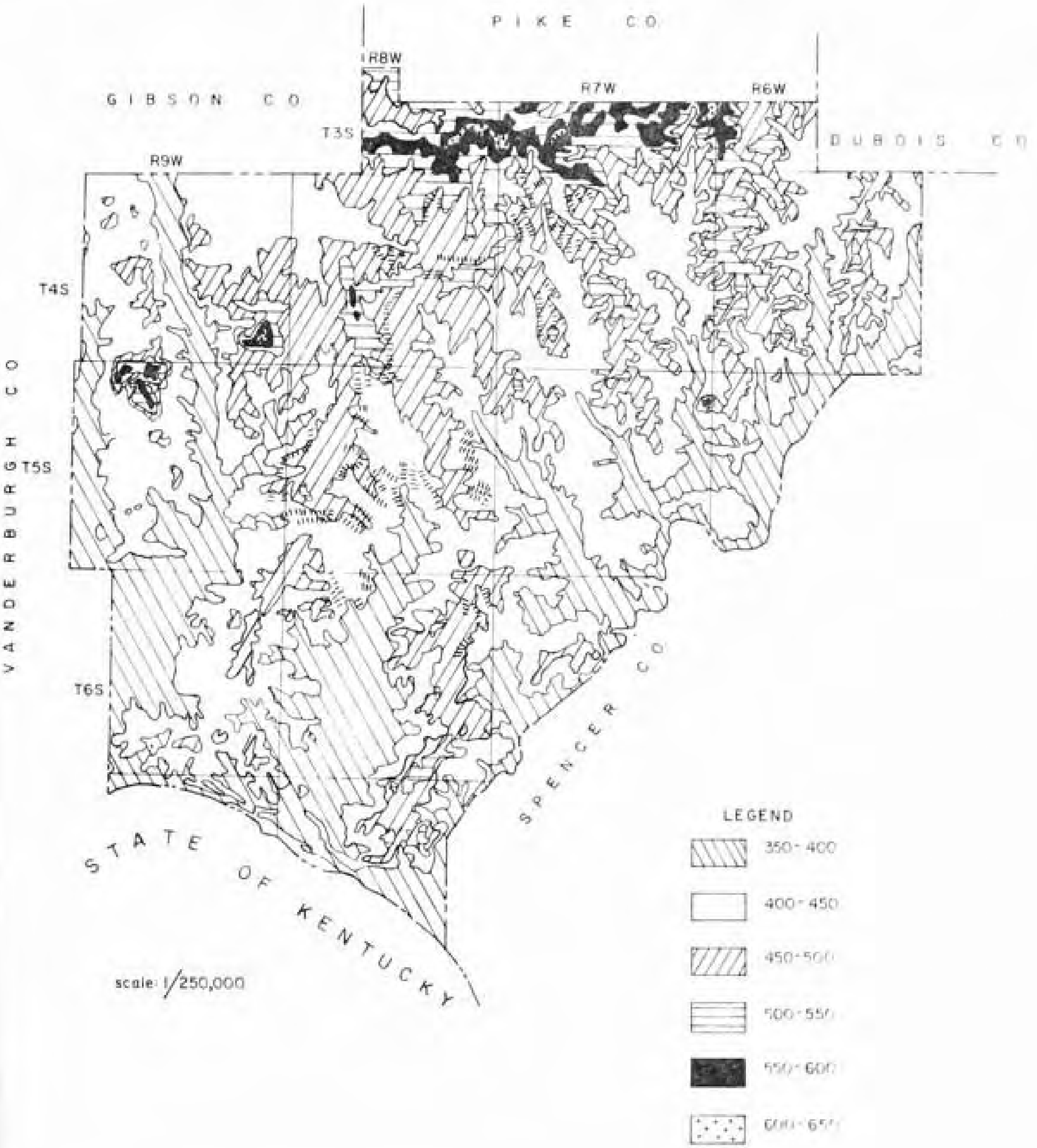

FIG. 5 TOPOGRAPHIC MAP OF WARRICK COUNTY

local relief of the county, about 200 feet (61 m), occurs at the Big Ditney Hill. Other noticeable ridges occur further to the east and to the southeast near the Ohio River.

Southwest of the ridge region, the surface of Warrick County is sloping downward toward the southwest. A rolling topography is predominant in this region. The rolling upland varies considerably in elevation but rarely exceeds 500 feet (152 m) above sea level. A few ridges and hills of various heights are found in this region. The Little Ditney Hill and Big Ditney Hill are the prominent ones as mentioned previously. A ridge located just north of Yankeetown reaches a height of 550 feet (168 m) above sea level. The majority of the hills in this region are characterized by their smooth, gently rounded forms with intervening shallow and broad valleys. Steep, precipituous bluffs 75 to 100 feet (23 to 30 m) in height occur along the Ohio River and Little Pigeon Creek.

Warrick County has many aggraded valleys and lacustrine plains. They vary in width from one to three miles (1.6 to 4.8 km) and are gently sloping from the upland toward the Ohio River. The altitude of the lacustrine plain along the Ohio River varies from 385 feet (118 m) to 390 feet (120 m). The alluvial plains along the Ohio River are 15 to 20 feet (4.5 to 6.1 m) below the surface of the adjacent lacustrine plain. Curvelinear current markings can be seen on the Ohio River flood plain at the southeastern corner of the county.

A few narrow sand and silt ridges may be observed at the southwestern corner and along the lacustrine plain of Pigeon Creek. These are wind deposits. The ridges are only a few feet (1 to 1.5 m) higher than the surrounding flat lacustrine plain.

Scattered from north to south along the central portion of Warrick County are a special man-made feature that can be recognized easily. This is the result of extensive strip mining of coal in the county.

The lowest elevation in Warrick County is about 340 feet (104 m) above sea level along the Ohio River at the border with Vanderburgh County to the west.

Geology

The surface and near surface geologic ages represented in Warrick County are the Quaternary period and the bedrock of Palezoic age. The Quaternary materials are both pleistocene and recent in age.

The general surface deposits of Warrick County are shown in Figure 6. The areas along the Ohio River and Little Pigeon Creek are classified as elastic sediments of silt, sand and gravel of the Martinsville Formation by Wayne (6).

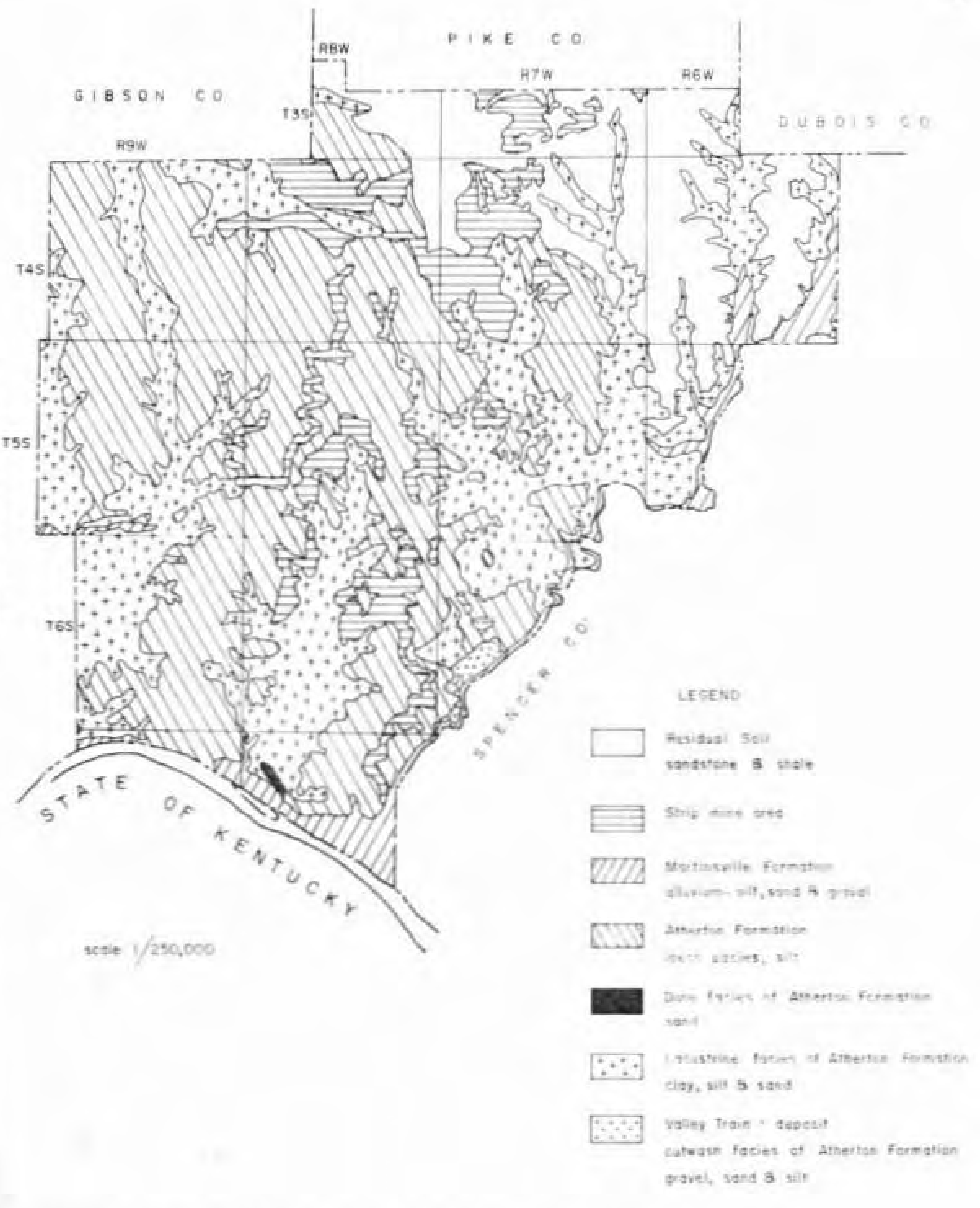

FIG. 6 UNCONSOLIDATED MATERIAL OF WARRICK COUNTY

A small area along Little Pigeon Creek located about three miles (4.8 km) northeast of Yankeetown is a valley train deposit. It is classified as the outwash facies of the Atherton Formation. The material in this deposit is mainly gravel, sand and silt.

Almost all of the wide drainage valleys in Warrick County are covered by lacustrine deposits. This clay, silt and sand deposits are classified as the lacustrine facies of the Atherton Formation.

The majority of the upland areas are covered by windblown silt deposits. It is classified as the loess facies of the Atherton Formation. A small area near the Ohio River is recognized as windblown sand deposit and classified as dune facies of the Atherton Formation.

The upland area in the northeastern quarter of the county is a residual soil area. The bedrocks underneath the residual soil and the unconsolidated surface materials are rocks of the Pennsylvanian period. The eastern part of Warrick County is underlain by the interbedded shale, sandstone, limestone, clay and coal of the Raccoon Creek Group (Figure 7). The majority of the county is on the interbedded shale, sandstone, limestone, clay and coal of the Carbondale Group. Isolated areas on the western part of the county belong to the interbedded shale, sandstone, limestone and thin coal of the lower part of the McLeansboro Group. The outline of the top of the Buffaloville coal member and the top of the Springfield coal member is shown in Figure 7. The columnar section of the bedrock in Warrick County is shown in Figure 8.

Land Form and Engineering Soil Areas

The engineering soils in Warrick County are derived both from the unconsolidated material and from the weathering of sandstone and shale bedrock (see Figure 6). The residual soils are confined mainly to the hills and ridges in the northeastern quarter of the county. The unconsolidated materials include both fluvial deposits and eolian deposits.

The entire county essentially is covered by loess deposits of various depth as indicated in Figure 9 and Appendix A (7). The deepest deposit occurs at the southwestern corner of the county and the depth decreases toward the northeastern corner. The depths of loess were measured on the flat areas where erosion of the deposit is at a minimum. The engineering soil areas within this region are subdivided according to the depth of the loess and its erosional conditions.

The deposits of transported materials are not homogeneous and variation should be expected. The general properties and profile of the soils for each area of different land form, are presented on the map that accompanies this report.

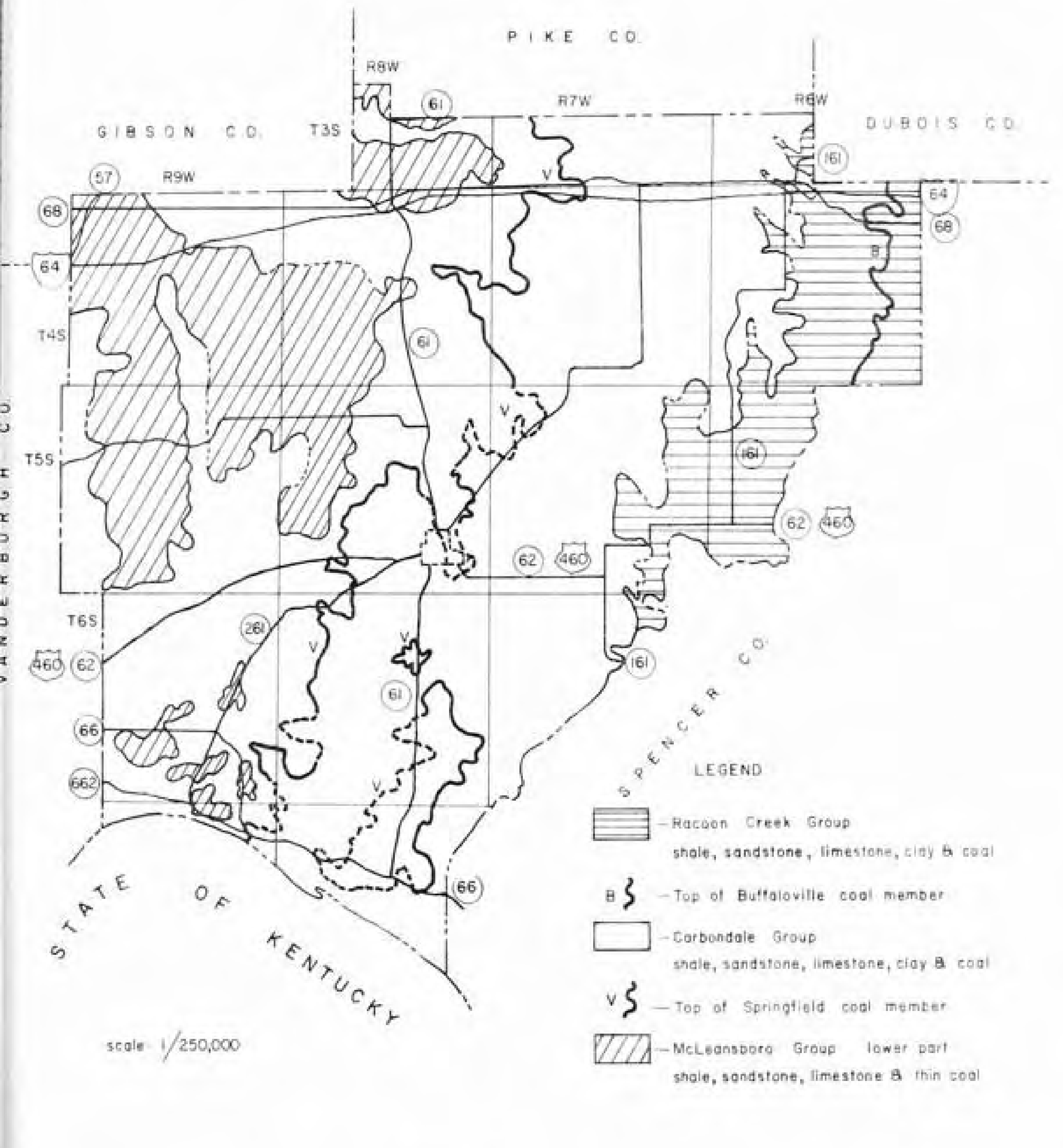

FIG. 7

BEDROCK FORMATION OF WARRICK COUNTY

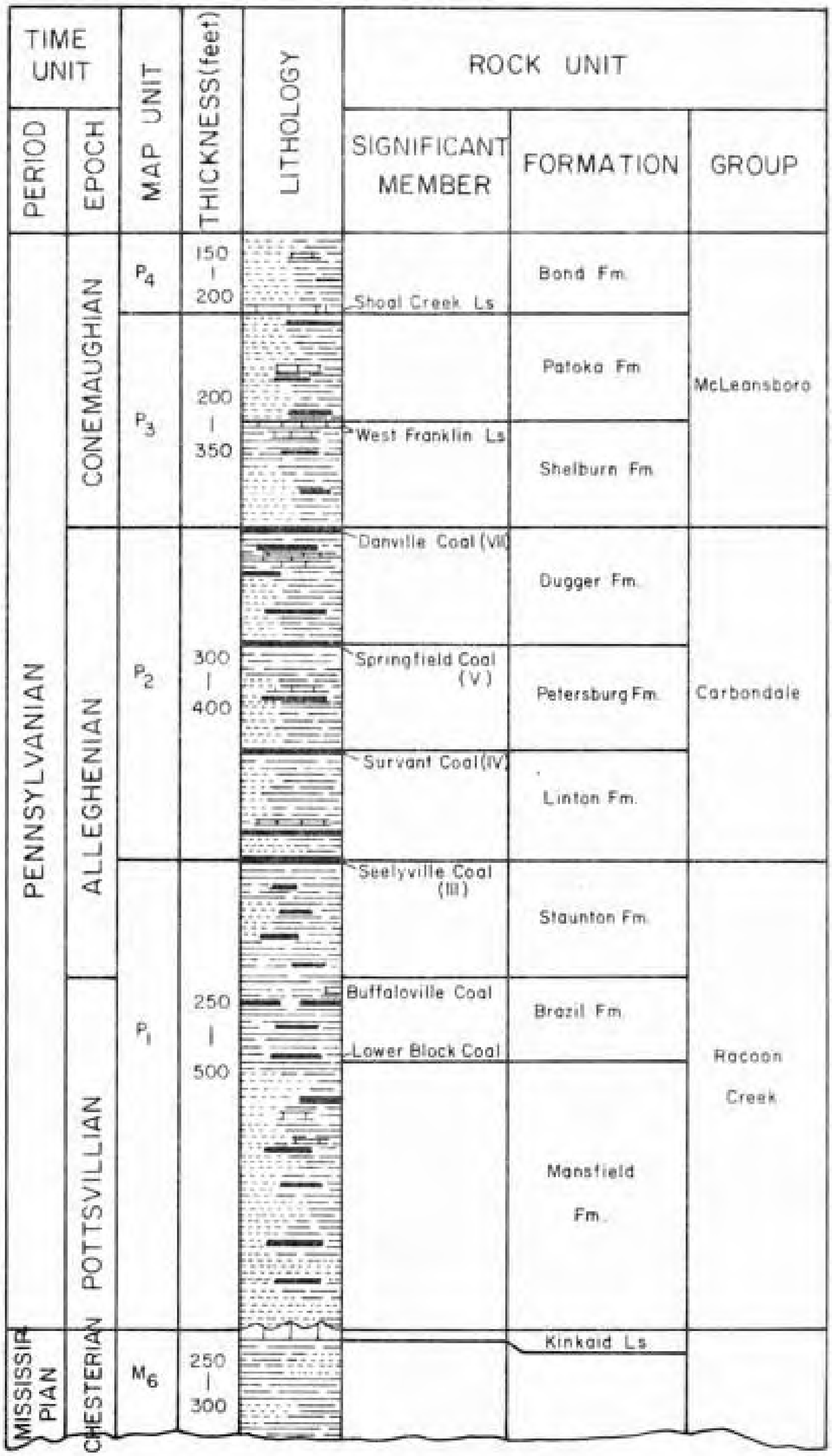

FIG. 8 COLUMNAR SECTION SHOWING BEDROCK UNITS IN WARRICK COUNTY.

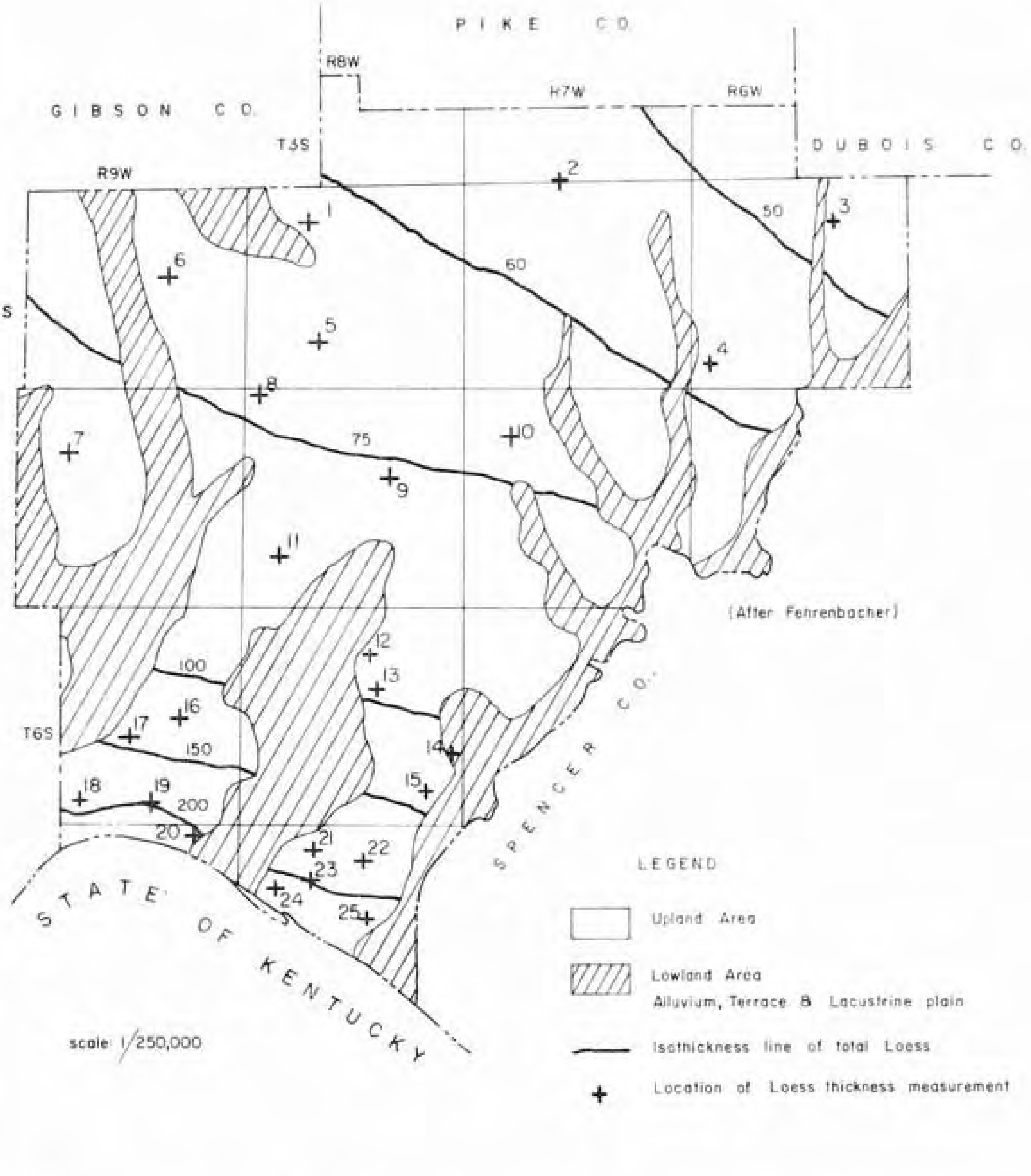

FIG. 9 ISOPACHOUS MAP OF LOESS DEPOSIT IN WARRICK COUNTY

Eolian Deposited Materials

There are extensive eolian (wind) deposits in Warrick County. The eolian deposits are subdivided into two groups: sand deposits and loess deposits.

1. Windblown Sand Deposits

Windblown sand deposits are very limited in Warrick County. They occur mainly on the lacustrine plain near the Ohio river flood plain. The largest dune is located about two miles (3.2 km) west of Yankeetown. Originally the dune is about ten feet (3 m) above its surrounding lacustrine plain as indicated in the 1940 airphotos. However much of the dune had been erased by the industrial complex on that site as shown in the 1977 airphotos. A few narrow sand dunes are located at the southwestern corner of the county. They are only a few feet (1 to 2 m) above the surrounding plain. With the new housing developments from both Newburgh and Evansville, most of them are no longer recognized from the ground. The outline of this deposit, however, is based on the 1940 airphotos.

Although the materials of the sand dunes are predominantly fine uniform windblown sand, a considerable amount of silt and clay particle are mixed with the sand especially on the surface layer.

The soil profile of the sand dune deposit consists of a fine sandy loam topsoil (A-4), a sandy clay loam to loam (A-6) subsurface soil. A silty clay loam (A-6) usually follows the loamy subsurface soil and a fine sandy loam (A-4) soil appears further down before the fine sand (A-3) parent deposit is reached.

Little or no problems other than stabilization and compaction are expected in this area. However, if deep cuts are required the characteristic of the underlying lacustrine deposit should be taken into account.

2. Windblown Silt Deposits

All of the uplands in Warrick County are covered by windblown silts or loess. The loess deposits are subdivided into groups according to the depth of the loess and the type of underlying materials. The subdivisions are: (a) moderately deep loess deposit, (b) loess covered lacustrine deposit, (c) loess covered sandstone-shale, (d) sandstone shale with a loess veneer.

(a) Moderately Deep Loess Deposits

About one seventh of Warrick County is considered as moderately deep (above six feet and up to 16 feet or 2 to 5 m) loess deposit. The loess deposits are thicker (about 16 feet or 5 m) at the southwestern corner of the county as illustrated in Figure 9 and Appendix A.

The thick loess deposits occur on all the ridge tops where erosion is at a minimum. The depth of the loess decreases rapidly towards the nearby streams and gullies.

The loess deposits in Indiana have been mapped previously by Moultrop on a regional basis (8). Some minor changes or refinements have been made for this county engineering soils map.

In the region near the center of the county where the loess is thinning toward the northeast, the moderately deep loess deposits are confined along the narrow ridge tops. In the southwestern portion where the loess deposit is thicker, the topography varies from undulating to gently rolling.

Surface drainageways are well developed along the major streams. The typical pinnate drainage pattern for deep loess deposits occur only occasionally.

The soil profile of the moderately deep loess deposit has a silt loam or silty clay loam (A-4 or A-6) soil in the A-horizon. The B-horizon is a more plastic silty clay loam to silty clay soil (A-6 to A-7-6). The C-horizon ranges from silt loam to silty clay loam (A-4 to A-6) soil. The interbedded sandstone and shale bedrock generally occur more than eight feet (2.5 m) below the surface.

The most typical boring is found along SR 62 and US 460 near Boonville. At sites Nos. 90, 91 and 93 the profiles show that beneath a six to nine inches (15 to 23 cm) of topsoil is a layer of silty clay loam (A-6) soil from three to three and a half feet (about one m) in thickness. A clay soil (A-7-6) is further down the profile. At site No. 92, however, a three and one half feet of clay (A-7-6) is directly below the six inches (15 cm) of topsoil and is underlain by seven feet (2.1 m) of silty clay loam (A-6) soil (9). The test boring sites Nos. 150, 152 and 153 along SR 61 shows a layer of silty clay (A-7-6) soil varies from two and one half to six feet (0.75 to 1.8 m) underlying a nine inch to one foot (20 to 30 cm) of silt loam (A-6) of top soil (10). Clay (A-7-6) soil was found below the silt clay subsurface soil at site no. 150 while silt loam (A-4) was found at sites No. 152 and 153 (10).

The test sites along SR 66 (Nos. 120, 121, 122 and 123) are in the area of a series of steep ridges. The ridges are covered with thick soils in excess of 15 feet (5 m). Due to the proximity of the Ohio River, the soil contains a high percentage of fine sand. The surface layer varies from loam (A-6) to sandy loam (A-4). However, a very stiff clay (A-7-6) was found at site No. 122 and a dense sand (A-2-4) soil was found at site No. 123. The clay soil at site No. 122 is located at a low topographic position. A layer of coal (six inches or 15 cm) was found below the three and one half feet (about 1.1 m) of clay. The clay has a high colloidal content (42.4%) and could probably be termed as a "fine clay" or very highly weathered "soapy" shale (11).

Test sites along SR 662 are located along the flood plain of the Ohio River. The profile is more erratic and more sandy. At site No. 110 ten and one half feet (3.2 m) of silt loam is underlain by 20 feet (6.1 m) of loose fine to medium sand (A-3) and then 4.5 feet (1.4 m) of dense fine sand (A-3) and three feet (1 m) of coarse sand (A-1-b) before the clay soil of the weathered shale layer is reached. At site No. 111, nine feet (2.75 m) of silt loam with streaks of sandy loam is underlain by 16 feet (5 m) of loose sand (A-3) and eight feet (2.4 m) of silty clay loam and silt loam. Site No. 112 is located on higher ground than the other two sites. It shows, beneath the six inches (15 cm) of silt loam topsoil, seven feet (2.1 m) of silt loam (A-4). At this site a clay soil with rock fragments (A-7-6) occurred 11 feet (3.3 m) below the surface and a five foot (1.5 m) layer of silt loam with weathered sandstone (A-4) was found at a depth 13.5 feet (4.1 m) below the ground surface (12). The depth of the overburden varied from 5.5 to 88.3 feet (1.7 to 26.7 m) on this project and the underlying interbedded layers of sandstone, limestone, shale and coal are sloping toward the Ohio River (11).

The grain size composition of loess in Warrick County taken at a point about two miles (3.2 km) northwest of Newburgh by Moultrop indicated that the sand content varies from 12 to 14%, while the silt ranges from 58 to 70%, and the clay component reaches 18 to 29% (8). The liquid limit and plastic index is higher at the surface layer and decreases with depth. The test indicated that the liquid limits varies from 48 at 18 inches (45 cm) to 32 at 60 inches (1.5 m) and the plastic index from 21 to 10 (8).

The engineering problems in this area are primarily the control of moisture during construction and compaction of the silty material. The subgrade will become weak under adverse moisture or due to frost action in winter. Pumping and erosion are potential problems in this region.

(b) Loess Covered Lacustrine Plain

A number of small areas located west of Newburgh and Chandler at the southwestern corner of Warrick County are recognized as loess covered lacustrine plains. The deposits have a gently undulating topography. They are slightly higher (less than ten feet or three meters) above their surrounding near-level lacustrine plain. The light and dark photo tonality indicating the high and low topographic positions in the deposits are very pronounced. Surface drainage channels are absent or poorly developed. Infiltration basins, however, are numerous in these deposits.

The soil profile is essentially the same as that of the moderately deep loess deposit. The topsoil varies from a silt loam (A-4) in the high position to a silty clay (A-6) with considerable amount of organic material in the low depressions. The B-horizon is more clayey in texture which ranges from silty clay loam to silty clay (A-4 to A-6 and A-7-6 at lower area). The C-horizon is composed of silty clay loam to silty clay (A-4 to A-6) soil. The underlying lacustrine deposit varies from silty clay to clay (A-6 to A-7-6). Along the long ridges located near the western border, fine sand may be found underlying the loess cover.

Special problems associated with this soil are essentially the same as those in the moderately deep loess region. However, if deep cuts are required the problem of weak support of the underlying lacustrine deposits should be taken into account.

(c) Loess Covered Sandstone-Shale

About one sixth of Warrick County is classified as loess covered sandstone-shale area. The deposit is confined mainly in the northern half of the county. The region is dissected by streams and gullies. The topography varies from a gently rolling surface in the western part to hilly in the east. Local relief in the order of 100 to 150 feet (30 to 45 m) is quite common in this region especially in the eastern portion. The influence of bedrock can be realized from the angular courses of the stream in this area, especially along Little Pigeon Creek (see Figure 3).

Since the sandstone-shale bedrock is covered by a blanket of loess with a thickness which varies from 18 to 60 inches (45 cm to 1.5 m) the upper soil profile is derived from the loess material. The topsoil is either a silt loam (A-4) or a silty clay loam (A-6) soil. The subsurface soil is predominantly silty clay loam (A-4 to A-6) soil. The weathered sandstone-shale residual soil may be found as sandy loam, silt loam, clay loam or clay under the loess deposits.

Most of the soil borings along I-64 listed in Appendix B represents this region.

Borings along I-64 show that the upper layer of the soil profile varies from silt loam to silty clay generally in an A-4 to A-6 classification. Occasionally, however, clay (A-7-6) soil may be found in a few spots. In general, the surface layer is a silty clay loam with (A-6) classification. A slightly more silty composition classified as (A-4) soil usually occurs just east of the flood plain of a stream. Boring sites Nos. 14 to 23 located east of the wide flood plain of Pigeon Creek illustrate this phenomenon. The silty clay soil taken at a depth from two to four feet (0.6 to 1.2 m) at site No. 1 classified as A-6(9) soil, contains 2% of sand 54% of silt and 44% of clay. At boring site No. 16 the sample taken from the surface to four feet (0 to 1.2 m) is classified as silty clay loam A-4(8) soil. The composition of the soil contains 6% of sand 73% of silt and 21% of clay. Most of the subsoil in this region is a shaly clay (A-6 to A-7-6) derived from the weathered shale. Coals are encountered in the borings at sites Nos. 29, 32, and 47. Sandstone is found more frequently in the boring hole from site No. 48 to the east especially at sites Nos. 51, 58, 63, 71, 72, 75, and 87. A typical profile of the region is illustrated in site No. 87. Under six inches (12 cm) of topsoil the profile shows 1.5 feet (45 cm) of silty clay loam (A-6) and followed by three feet (90 cm) of silty clay A-7-6(16). Further down the profile is a layer of 6.5 feet (2 m) of shaly clay (A-6) and then 3.5 feet (1.1 m) of weathered shale, 0.5 feet (15 cm) of limestone, four feet (1.2 m) of weathered shale with a coal seam, 3.5 feet (1.1 m) of weathered sandstone and finally sandstone bedrock (13, 14, 15, 16).

Engineering problems in this soil region are generally associated with the different characteristics of the underlying residual bedrock soils and bedrock materials. A shallow cut and fill may encounter several different materials in a short distance.

(d) Sandstone-Shale With Loess Veneer

Sandstone-shale with loess veneer soils are scattered in the loess covered sandstone-shale region confined to the northern half of Warrick County. Five large isolated hills and ridges are found in the northwestern quarter of the county. Dyson Knob reached the highest elevation (658 feet or 200 m above sea level) of Warrick County is located north of Lynnville. The other hill (617 feet or 188 m) about 1.5 miles (2.4 km) east of the knob is called Ringham Hill. Between Elberfield and Millersburg there are the Little Ditney Hill (about 590 feet or 180 m) and the Big Ditney Hill (about 648 feet or 198 m) situated on the west and the east side of Pigeon Creek respectively. A prominent ridge is located about 2.5 miles (4 km) east of the Big Ditney Hill. The ridge with an elevation of 573 feet (175 m) is high above its surrounding land.

The rest of the sandstone-shale with loess veneer areas are confined to the valley wall areas and the slopes of the ridges or hills where erosion has removed not only most of the loess deposit but some of the residual soils of the sandstone-shale. The topography of this region is extremely rugged and blocky. Gullies are numerous and closely spaced. A white fringe which reflects the bare soil or rock of the area can be seen on the aerial photographs.

The area usually has 18 to 25% slopes. Steeper slopes may occur along the gully land. The land is suitable only for forest.

The soil profile varies greatly depending on its topographic position, erosional situation and the rock types. On a normal soil profile the topsoil varies from a sandy loam to silty clay loam (A-4). It is underlain by silt loam or silty clay (A-4 to A-6) soil with considerable amount of stone fragments before the interbedded sandstone and shale bedrock is reached. The bedrock generally can be found at a depth from 15 to 42 inches (38 cm to 107 cm) from the surface. However, in places, where the erosion is severe, the top layer may be removed and the underlying bedrock exposed. This may be considered as non-soil area.

Test sites No. 28, 29, 37 and 38 are located within this region. The profile at site No. 28 shows a silty clay loam (A-4) of 2.5 feet (75 cm) underlying the six inches (12 cm) of topsoil and this layer is followed by a two feet (60 cm) layer of silty clay (A-6) soil and a clay A-7-5 soil further down the profile. The last layer is likely to be a weathered residual soil of shale. At site No. 29 a three feet (91 cm) layer of silty clay loam (A-4) soil is sandwiched between one foot (30 cm) of topsoil and three feet (91 cm) of clay with shale and coal fragments (A-7-5). A silty clay A-6 soil is found further down the profile (14).

Shale is encountered at eleven feet at site No. 37 which is overlain by 4.5 feet (1.4 m) of silty clay (A-6) subsurface soil. At site No. 38 seven feet (2.1 m) of clay (A-7-6) soil occurs under six inches (12 cm) of topsoil. A shaley clay (A-7-6) is found about 7.5 feet (2.3 m) from the ground surface (14).

The engineering problems associated with this region are associated with the cuts and fills. Different types and characteristics of residual soils or bedrock may be encountered within short distances both horizontally and vertically.

Fluvial Deposited Materials

About one third of Warrick County is covered by fluvial deposited materials. Three different land forms created by the action of water namely, lacustrine plain, terrace and alluvial plain are discussed.

1. Lacustrine Plain

About half of the fluvial deposited materials in Warrick County are classified as lacustrine deposit or slack water deposit. These lacustrine plains were formed in the lower valley of the tributaries along the Ohio River during the Wisconsinan glaciation period (17). Huge lacustrine plains are found along Pigeon Creek, Cypress Creek, Otter Creek and Cole Creek. The extent of the lacustrine deposits along these Creeks is much larger than the mapped boundary in the attached map because around the edges the lacustrine deposits have been buried by alluvial deposits. These latter areas are classified as alluvial deposits on the map.

The altitude of the lacustrine plain in Warrick County varies between 380 to 400 feet (113 to 122 m) above sea level. The surface is flat and devoid of natural drainage development in the huge lacustrine plains. Ditches were dredged in these areas to facilitate the drainage. Short and steep gullies may be found along the edge of the plains and the stream valleys.

The uniform dark tone of the huge lacustrine plain on the aerial photographs is broken occasionally by scattered small light tone of low mounds which indicates a better drainage position of the slightly higher thin loess deposits. Shallow fine sand deposits may be found in the lacustrine plain near the Ohio River. Since the mounds are small and the loess or sand deposits are thin no separation is made on the engineering soils map.

The lacustrine plains are covered by a loess veneer from 6 to 40 inches (15 to 100 cm) in depth. The soil is developed partly from the thin loess cover and partly from the sheet wash materials from the uplands. The topsoil varies from a silt loam to a silty clay loam (A-4) in the high position. A somewhat coarser textured (sandy loam) topsoil occur in the areas along the Ohio River. The B-horizon ranges from a silty clay loam to clay (A-6 to A-7) in general except the areas along the Ohio River where sandy loam (A-4) soil prevails. Stratified silt, clay and fine sand are found beneath the subsoil. At the lower areas the topsoil may contain some organic matter and has a silty clay to clayey (A-6) texture. The B-horizon is silty clay to clay (A-7) without organic matter. Stratified clay and silty clay is found as parent material.

Test borings along SR 66 illustrated the sandy texture of the deposit. At sites Nos. 113, 114, 115, and 119 the surface soil varies from a depth of 0.7 to 3.4 feet (21 cm to 105 cm) is classified as a sandy loam (A-4) soil. It was classified as loam (A-4) and silt loam (A-4) soil at sites No. 116 and No. 118 respectively. The subsurface layer varies from sand (A-3) in site No. 113 to sandy loam (A-4) at most of the sites. However, clay loam (A-6) is found at site No. 114 and clay (A-7-6) appeared at site No. 118.

The most typical lacustrine soil is found along SR 61 from sites No. 124 to 129 and 155 to 158. The topsoil varies from a silty clay loam to silty clay (A-4 to A-6). The subsurface soil is clayey (A-7-6) in general.

Boring sites along SR 62 and US 460 show the lacustrine deposit is rather thin. The surface soil is a silt loam to silty clay loam (A-4 to A-6) and the subsurface soil varies from silty clay loam to clay (A-4 to A-7-6). At a slightly depressed site (No. 100) the shaly clay A-7-6 soil is encountered below one foot (30 cm) of clayey topsoil (A-7-6) with some organic matter. At site No. 101 the shaly clay soil (A-7-6) is only 6 inches (15 cm) below the topsoil. Between sites 105 and 106 it is indicated that the shaly clay A-7-6 soil underlies nine feet (2.75 m) of silt loam (A-4) soil.

The engineering problem associated with the lacustrine or slack water plain are high water table, low load carrying capacity and settlement of heavy structures.

2. Terrace Deposits

A few scattered terrace deposits are recognized in Warrick Councy. Those along the Little Pigeon Creek south of Bullocktown are quite different from the rest. Therefore they are subdivided into high terrace and slack water terrace or low terrace.

(a) High Terrace

The terraces along Little Pigeon Creek south of Bullocktown is actually part of a hugh Ohio River terrace extending eastward into Spencer County.

Current scars, swales and low ridges are numerous on this terrace. However, infiltration basins which are a common feature for coarse-textured terrace deposits are absent.

The terrace has a flat to gently undulating surface. The altitude is about 380 feet (116 m) above sea level. The Little Pigeon Creek cuts across the deposit.

The texture of the deposit varies greatly from place to place. On the high position, the surface soil ranges from a sandy loam to a silt loam (A-4). The B-horizon varies from sandy clay loam to silty clay loam (A-6). The parent material generally consists of stratified sandy loam, sand, silt loam and silt. On the low topographic position, the surface soil ranges from loam to silty clay loam (A-4 to A-6). The B-horizon is a silty clay or clay (A-7). Stratified silt loam, silty clay loam, loam, clay loam and sandy loam may be found in the parent material.

Settlement problems can be expected in this area. For heavy structures, the subsurface soil should be investigated thoroughly.

(b) Slack Water Terrace

A few slack water terraces can be recognized in Warrick County. Most of them occur along the upper reach of Wallace Fork and Pokeberry Creek. Others are scattered along Coles Creek, Otter Creek and Bluegrass Creek.

The slack water terraces are extremely flat and only slightly higher than the adjacent flood plain. The topographic break between the flood plain and the slack water terrace is inconspicuous. Infiltration basin and current scars are completely missing in those terraces. Surface drainage channels are absent also.

The soils of the slack water terrace are developed from stratified silt loam, silty clay loam, loam and fine sand. The surface soil is mixed with alluvium washed in from the upland.

The soil profile on this deposit consists of silt loam to silty clay loam (A-4) topsoil, a silty clay loam to silty clay (A-4 to A-6) subsurface soil, a somewhat less plastic subsoil (A-6) and the stratified silt loam, silty clay loam, loam and fine sand may be found at depth in the profile.

The major problems associated with this area are the high water table, instability of the silty soils and occasional overflow.

3. <u>Alluvial Plains or Flood Plains</u>

More than half of the fluvial deposits of Warrick County belongs to the alluvial plain or flood plain. The extent of mapping of these plains was determined by the scale of the engineering soils map.

Due to the different sources of the alluvial materials and the form of their deposition the flood plains in this county are subdivided into Ohio River flood plains, the alluvial plains of the aggraded valleys in the sandstone-shale region and the alluvial plain in the loess region.

(a) <u>The Ohio River Flood Plains</u>

The Ohio River flood plain has a nearly flat surface except where broken by a series of low current scars. Surface drainage is channeled along the sloughs or scars created by the currents of the flood water. The altitude of the flood plain varies from 360 to 370 feet (110 to 113 m) above sea level.

The soil textures varies according to their topographic and geographic position. Coarser textured deposits are found in the natural levee near the channel. A finer textured deposit usually occurs in the slough and near the upland.

The soil profile in the high position has a sandy loam to silty clay loam (A-4) soil. The subsurface soil is about the same texture. Stratified silt loam and silty clay loam soils are found further down in the profile.

At the low topographic position, the surface soil varies from a silt loam to a clay (A-6 to A-7). The subsoil ranges from silty clay loam to clay (A-7). The stratified deposits further down are interbedded silty clay loam, silty clay and clay. Lenses of sand and gravel may be found at depth.

The major engineering problem is associated with flood or high waters, the danger of scour and the weak supporting power of the unconsolidated deposits.

(b) Alluvial Plains of the Aggraded Valley in Sandstone-Shale Region

All the alluvial plains in the northern half of Warrick County are classified as alluvial plains of the aggraded valley in the sandstone-shale region. The deposits of the alluvial plains are derived from the erosion of the surrounding loess covered sandstone and shale uplands. The highly erosive loess fills the valleys with silty deposits. The alluvial plain slopes gently from the upper reach toward the lower reach with a steeper gradient at the upper end. All of the alluvial plains along the major tributaries of the Ohio River disappear or merge with the lacustrine plains downstream. In fact, many of the wide flood plains were lacustrine plains originally but covered subsequently by the alluvial deposits. Some alluvial plains cut narrow meandering paths through the huge lacustrine plains. Channels are dredged and straightened in the wide flat alluvial plains to facilitate drainage of the valleys.

Since the soil of the region is derived from the uplands, coarser textured materials may be expected adjacent to the foot of the upland and finer-textured material further downstream.

The soil profile varies from a silt loam to a silty clay loam (A-4 to A-6) topsoil with a similar subsurface soil which is underlain by stratified silt loam, loam and sand with fragments of sandstone and shale deep down in the profile.

Many boring sites along I-64 are located in this region. Boring sites Nos. 10, 11, 12 and 13 are located within the wide flood plain of Pigeon Creek. The top layer ranges from five to 10.5 feet (1.5 to 3.2 m) and is classified as silty clay loam (A-6) soil. Except at site No. 10 the underlying layer ranges from one to eight feet (30 cm to 2.45 m) and are more silty in texture. This layer is classified as silty clay loam but is an A-4 soil in the AASHTO classification. At No. 10 site, however, it is a little more clayey and classified as silty clay (A-6) soil. The variability of the texture of the profile are illustrated at sites Nos. 11 and 12. At a depth of 11.5 feet (3.5 m) from the surface a four foot (1.2 m) layer of sandy clay (A-4) soil is encountered and this is followed by 1.5 feet (46 cm) of sand (A-1-b), 25 feet (76 cm) of sandy clay loam (A-4), five feet (1.5 m) of sand (A-1-b) before a shaly clay (A-6) soil is reached. At site No. 12, however, a 2.5 feet (76 cm) of sandy clay loam (A-4) soil occurs 14.5 feet (4.4 m) below the ground surface. It was then followed by a 2.5 foot (76 cm) of silty clay (A-6) soil and six feet (18 m) of shaly silty clay (A-6), two feet (60 cm) of silty clay loam (A-4) and 1.5 feet (45 cm) of sandy clay loam (A-4) before reaching to the shaly hard clay (A-6) stratum.

Site No. 54 is located along the edge of a flood plain. The profile is composed of 1.5 feet (45 cm) of silt loam (A-4) soil, followed by 5.5 feet (1.7 m) of clay loam (A-6) and more than 4.5 feet (1.4 m) of silt loam (A-4) further down.

Sites Nos. 61 and 62 are situated on a narrow flood plain. Below one half foot (15 cm) of topsoil lies two feet (60 cm) of clay (A-7-6) at site No. 61 but 6.5 feet (2 m) of sandy clay loam (A-6) at site No. 62. A sandy loam (A-2-4) soil occurred at both sites for a depth of 2.5 feet (75 cm) before a shaly clay (A-6) soil was reached. Further east in the main flood plain (boring No. 65) the profile is essentially silt loam (A-4) to a depth of more than 30 feet (9 m).

On the narrow flood plain where boring sites Nos. 73 to 76 are included the deposit is shallow. Underneath one half foot (15 cm) of topsoil the soil has a texture of silty clay loam (A-6). The shaly clay is reached at a depth of four feet (1.2 m) from the surface at site no. 73. Sandstone and shale fragments occur below a depth of four feet (1.2 m) at site No. 74. A deeper profile is found at sites Nos. 75 and 76. A shaly clay (A-7-6) soil is found eight feet (2.4 m) below the ground surface underlain six feet of silty clay (A-7-6) soil at site No. 75. Clay soil with shaly fragments occurs at a depth of 13 feet (4 m) below the ground surface and this is overlain by seven feet (2.1 m) of silt loam (A-4) soil at site No. 76.

Some organic matter is found in the profile at sites Nos. 80 and 81. The profile at site No. 80 consists of one-half foot (15 cm) of topsoil, 15.5 feet (4.7 m) of silt loam (A-4), 6.5 feet (2 m) silty clay with organic matter (A-6), 11 feet (3.3 m) of loam with organic matter (A-4), 11 feet (3.3 m) of silty clay with organic matter (A-6) and then sandstone. At site No. 81 the profile is similar. There were 8.5 feet (2.6 m) of silty clay with organic matter (A-6) and followed by 6.5 feet (2 m) of silt loam (A-4), 5 feet (1.5 m) of silt loam with organic matter (A-4), 7.5 feet (2.3 m) of loam with organic matter (A-4), 2.5 feet (75 cm) of silty clay with organic matter (A-6) and 7.5 feet (2.3 m) of clay (A-7-6) before sandstone stratum is reached.

The engineering problems in this area are associated with high water and frequent flooding. Subgrade support is poor during the wet season. Settlement may become a problem for heavy structures.

(c) Alluvial Plains in the Loess Region

Alluvial plains in the loess region are confined to the southern half of Warrick County. The general feature of the alluvial plains in this region and those in the sandstone-shale region are about the same except that the valley is somewhat narrow in the loess region. The channels are also dredged and straightened to improve drainage. Since the deposit is derived from the surrounding loess upland silt is the predominant material of the soil.

The surface soil of this deposit is a silt loam (A-4). The subsoil is a somewhat plastic silt loam or silty clay loam (A-4 to A-6). The underlying material is a friable stratified silt loam and silt.

Boring site No. 96 along SR 62 and US 460 is located in this area. The surface of this plain is three feet (90 cm) higher than the lacustrine plain to the east. The profile shows that under a thin (four inches or ten cm) topsoil a silt loam with a trace of organic matter (A-4) soil is found more than 5.7 feet (1.75 m) in depth.

Borings Nos. 128 and 141 along SR 61 are located in the narrow alluvial plains cut through a huge lacustrine plain. The profile at site No. 128 shows a 1.5 feet (45 cm) of soft silty clay loam (A-4) overlying one half foot (15 cm) of decayed wood and then silt clay loam (A-6) soil. At site No. 141 where the boring is close to the main channel of Cypress Creek the profile is quite different. The upper 2.5 feet (75 cm) layer is a soft to medium stiff clay with a little gravel and a trace of organic matter and is classified as A-7-6. The lower stratum is a very stiff clay classified as A-6 soil.

Runoff is slow in this region. The area is subjected to flooding in winter and spring. Wetness and weak supporting power of soil are the major problems in this area.

Miscellaneous

Strip Mines

Intensive coal mining operations can be observed from airphotos of Warrick County. The special saw teeth pattern of strip mine spoil banks can be identified very easily in the 1940 airphotos. Many of the reclaimed mines especially those near Boonville are rather difficult to detect after the surface has been leveled.

The strip mine operation is concentrated near the central part of the county in a north-south direction. It follows closely with the Springfield coal member as illustrated in Figure 7.

The strip mines have been updated using the 1977 airphotos. Many new mines have been opened and old mine areas expanded since the 1977 photography; therefore, the areas marked on the engineering soils map can be considered accurate up to 1977 only.

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APPENDIX A

LOESS THICKNESS MEASUREMENT IN WARRICK COUNTY: BY J. B. FEHRENBACKER

Site No.	Township	Range	Section	Total Depth in Inches	Underlying Material
1	4S	8W	8, NW 1/4, NE 1/4	50	Silty Clay Shale Soil
2	4S	7W	4, NW 1/4, NW 1/4	50	Sandy Loam SS Soil
3	4S	6W	11, SE 1/4, NW 1/4	45	Red Very Heavy Shale Soil
4	4S	6W	31, SE 1/4, NW 1/4	55	SS Soil
5	4S	8W	28, SW 1/4	84	Gritty Silty Loam
6	4S	9W	23, NW 1/4, NW 1/4	60	SS Soil
7	5S	9W	8, SE 1/4	100	SS
8	5S	8W	6, NW Corner	70	Sh Soil
9	5S	8W	14, SW 1/4, NW 1/4	48	Shaley SS
10	5S	7W	8, NW 1/4, NW 1/4	75	Sh & SS Residuum
11	5S	8W	29, SE 1/4, SW 1/4	70	SS-Sh Soil
12	6S	8W	10, NE 1/4	75	Sh & SS Residuum
13	6S	8W	15, NE 1/4, NE 1/4	85	Sh Residuum
14	6S	8W	25, NE 1/4, NW 1/4	96	SS
15	6S	8W	35, NE Corner	105	Sh and SS
16	6S	9W	23, SW 1/4, SW 1/4	100	Sh Soil
17	6S	9W	22, SW 1/4, SW 1/4	96	SS at 9 1/2 Feet
18	6S	9W	32, NE 1/4	96	SS
19	6S	9W	34, NW 1/4, NE 1/4	120	Sh Soil
20	7S	9W	1, Near Center, SW 1/4	288	Red SS Soil
21	7S	8W	5, NE 1/4, SE 1/4	90	
22	7S	8W	3, NE Corner, SW 1/4	120	Red Sandy Loam SS Soil
23	7S	8W	8, NE 1/4	90	SS
24	7S	8W	7, NW 1/4	100	Sh
25	7S	8W	15, Center	215	SS Soil

APPENDIX B

The soil test data tabulated below was obtained from consultants' reports prepared for the Indiana State Highway Commission. The location of the site is shown on the attached engineering soils map. Considerable additional data is contained in the consultants reports.

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
1	1675+00		2-4	Silty Clay	A-6(9)	0	2	54	44	36	23	13	20
2	1682+00	42rt	1.0-2.5	si cl 1	A-6(8)	10	16	51	23	33	22	11	21
3	1692+00	421t	1.5-2.5	si cl	A-7-6(12)	1	5	59	35	42	22	20	18
4	1710+00	701t	7.5-9.0	clay (shaly)	A-7-5(20)	8	15	19	58	67	30	37	13
5	1733+50	421t	7.5-9.0	si cl (shaly)	A-6(10)	0	1	56	43	39	24	15	15
6	1743+50	160rt	12.5-14.0	clay (shaly)	A-7-6(15)	1	1	29	69	46	21	25	18
7	1750+50	421t	1-4	si cl 1	A-6(10)	1	6	64	29	35	20	15	22
8	1760+00	421t	0-6	si cl	A-7-6(12)	0	4	63	33	41	22	19	18
9	1770+50	421t	6-8	si 1	A-4(8)	9	23	51	17	28	20	8	21
10	1780+00	42rt	0.5-2.0	si cl 1	A-6(8)	1	6	70	23	33	22	11	22
			6-8	si cl	A-6(10)	0	4	54	42	34	19	15	15
11	1786+50	42rt	17.5-19	sa cl 1	A-4(3)	25	39	19	17	31	23	8	19
			20-21.5	sand	A-1-b(0)	41	47	7	5	22	18	4	16
			25-25.5	clay (shaly)	A-6(10)	0	3	35	62	38	23	15	20
12	1800+00	421t	10.0-11.5	si cl 1	A-4(8)	0	6	69	25	31	21	10	19
			22.5-24	si cl (shaly)	A-6(12)	0	11	52	37	37	18	19	17
13	1814+00	42rt	22.5-24	si cl 1	A-4(8)	0	13	67	20	26	21	5	19
14	1827+00	42rt	17.5-17.9	cl 1 (shaly)	A-6(9)	25	22	33	20	35	20	15	20
15	1830+00	701t	22.5-23.5	clay (shaly)	A-7-6(12)	1	2	23	74	44	26	18	19
16	1846+70	42rt	0-4	si cl 1	A-4(8)	0	6	73	21	29	21	8	19
17	1857+00	421t	9-10.	clay	A-7-6(19)	1	6	41	52	55	19	36	15
18	1863+50	421t	0-2	sandy 1	A-6(3)	27	41	20	12	35	21	14	22
19	1890+00	42rt	3.5-6.0	si cl 1	A-4(8)	6	12	63	19	28	21	7	20
20	1892+00	421t	10-12	clay (shaly)	A-6(8)	4	18	43	35	32	21	11	16
21	1899+00	42rt	12-14	clay (shaly)	A-7-6(15)	0	4	37	59	47	24	23	13
22	1902+50	421t	8-10	si cl	A-7-6(14)	2	7	49	42	44	20	24	15
23	1905+00	42rt	4-6	si cl	A-7-6(14)	0	3	52	45	44	21	23	17
24	1926+00	421t	8-10	si cl	A-6(12)	1	8	55	36	38	19	19	17

Site	Station	Offset (ft.)	Depth (ft.)	Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
25	1928+00	42rt	15-16.5	clay (shaly)	A-7-6(13)	1	4	38	57	42	20	22	19
26	1931+00	42lt	2-6	si cl l	A-7-6(14)	3	14	58	25	44	21	23	15
			12.5-14	clay (shaly)	A-6(10)	2	17	47	34	37	22	15	22
27	1952+00	42rt	0.5-2.5	si cl l	A-6(10)	5	11	62	22	32	17	15	16
28	134+50	42lt	5-7	clay	A-7-5(18)	0	2	38	60	56	30	26	13
29	147+00	42rt	7-8.5	si cl	A-6(12)	0	10	56	34	37	18	19	19
30	157+50	42lt	0.5-1.5	si cl l	A-4(8)	4	13	56	27	33	26	7	22
			1.5-3.0	si cl	A-7-6(18)	1	3	59	37	49	19	30	18
31	168+00	42lt	6-8	cl (shaly)	A-7-6(17)	6	27	27	40	50	21	29	19
32	173+00	42lt	6-8	si cl	A-6(10)	0	13	55	32	35	21	14	22
33	190+00	42rt	1-3	si cl l	A-6(10)	8	20	47	25	34	20	14	16
			4.5-6	si cl l	A-6(10)	1	6	67	26	32	18	14	19
34	208+00	42lt	2-4	si cl l	A-4(8)	3	16	56	24	28	20	8	21
35	223+50	50lt	4-5	clay (shaly)	A-7-6(20)	11	20	10	59	75	26	49	20
36	225+50	42lt	4-5.5	clay (shaly)	A-6(10)	13	30	29	28	37	18	19	19
37	245+00	12lt	1.5-3	si cl	A-6(10)	1	6	55	38	37	21	16	21
38	250+00	42lt	2.5-4	clay	A-7-6(16)	2	13	48	37	47	20	27	21
39	256+00	42lt	0.5-2.5	clay	A-7-6(20)	6	18	22	54	75	26	49	19
40	271+50	30rt	8.5-10.1	sa l	A-2-4(0)	23	57	14	6	NP	NP	NP	NP
41	272+50	70rt	0.5-1.5	si cl l	A-4(8)	1	5	71	23	32	26	6	27
42	275+00	70rt	0.5-2.5	si cl	A-7-6(14)	1	5	55	38	45	22	23	25
			12.5-14	si cl l	A-6(10)	0	22	51	27	34	18	16	17
43	301+00	70lt	3.5-5	si cl l	A-7-6(19)	0	7	68	25	56	23	33	13
44	308+50	42lt	5-7	clay	A-7-6(20)	1	6	29	64	48	25	43	12
			7-8.5	si cl l(shaly)	A-4(8)	2	11	64	23	33	25	8	22
45	319+00	70rt	7.5-9	clay	A-7-6(14)	13	37	17	33	51	23	28	14
46	330+75	42rt	0.5-2.5	cl l	A-6(9)	15	26	35	24	37	21	16	21
			6-8	si cl (shaly)	A-6(8)	0	4	60	36	31	20	11	18
47	342+00	70lt	10-10.3	si l	A-4(8)	1	16	67	17	NP	NP	NP	NP
48	357+00	65lt	1-2	si cl l	A-6(8)	0	1	75	24	34	22	12	12
			12.5-14	clay (shaly)	A-7-6(20)	1	10	16	73	59	23	36	16
49	369+00	42rt	7-8	clay	A-7-6(20)	0	4	32	64	73	28	45	10
50	372+75	42lt	17.5-18	si cl (shaly)	A-6(9)	2	13	52	33	33	20	13	20
51	388+50	42lt	0.5-2	si cl	A-7-6(13)	0	3	59	38	45	25	20	16
52	398+00	42rt	12.5-13.3	si l	A-4(8)	2	10	70	18	30	22	8	18
53	415+50	60lt	0-2	si l	A-4(8)	4	13	65	18	36	27	9	26
54	442+50	42rt	5-6.5	cl l	A-6(9)	13	32	35	20	37	21	16	22
55	449+50	42lt	9-1.0	clay (shaly)	A-6(10)	0	7	43	50	34	18	16	15
56	456+00	42lt	0.5-2	si cl	A-7-6(17)	0	2	59	39	51	24	27	12
57	474+00	70lt	2.5-4	clay (shaly)	A-6(10)	0	25	39	36	29	14	15	14

Site	Station	Offset (ft.)	Depth (ft.)	Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
58	478+00	70rt	0-2.5	si cl	A-7-6(15)	0	3	63	34	48	25	23	19
59	493+00	42rt	7.5-8.8	clay (shaly)	A-6(9)	2	26	41	31	33	20	13	15
60	496+00	42lt	5.5-7	clay	A-7-6(19)	3	12	39	46	54	23	31	16
61	505+75	42lt	2.5-4	sa l	A-2-4(0)	21	52	19	8	29	19	10	19
			10-11.5	sa cl l	A-6(3)	2	51	26	21	27	16	11	11
62	511+00	42rt	15-16.5	cl l	A-6(9)	0	31	43	26	32	18	14	18
63	517+00	70rt	21-23	si l	A-4(8)	5	28	49	18	25	18	7	13
64	518+50	65lt	2.5-3.5	cl l	A-6(11)	0	25	49	26	35	18	17	17
65	529+50	42lt	15-16.5	si l	A-4(8)	1	18	65	16	27	20	7	19
			20-21.5	si l	A-4(8)	0	20	61	19	29	20	9	10
66	566+00	42lt	2.5-6	si cl	A-6(10)	1	11	59	30	38	22	16	22
67	572+00	42lt	6-7.3	clay (shaly)	A-7-6(14)	1	3	46	50	50	29	21	27
68	580+00	42lt	12.5-1.3	si cl (shaly)	A-7-6(12)	0	2	57	41	42	22	20	21
69	580+50	42rt	4-5	si cl	A-6(11)	0	5	51	44	38	20	18	18
70	611+00	42lt	5-7	clay	A-7-6(16)	6	16	45	33	48	22	26	20
71	634+00	42lt	10.5-11.4	sa l	A-2-4(0)	0	76	10	14	24	20	4	20
72	639+00	42rt	0-1.5	si cl l	A-6(8)	1	7	66	26	31	20	11	20
73	675+00	42rt	0.5-3.5	si cl	A-6(11)	1	10	55	34	38	20	18	20
			5-6	clay (shaly)	A-7-6(18)	1	8	42	49	53	25	28	25
			6-12	si cl (shaly)	A-6(10)	8	11	52	29	37	22	15	20
74	679+00	42lt	19.5-21	cl l	A-6(8)	3	24	47	26	33	22	11	23
75	690+00	70rt	0.5-2	si cl l	A-6(9)	1	6	65	28	35	22	13	20
			3-4	si cl	A-7-6(12)	6	13	53	28	41	21	20	17
76	698+00	42lt	16-17.5	clay	A-6(13)	12	37	25	26	38	15	23	15
77	728+00		2-6	clay (shaly)	A-7-6(16)	0	3	47	50	51	27	24	26
78	732+30	42rt	3-5	clay (shaly)	A-7-6(17)	1	9	38	52	49	22	27	19
			11-12	clay	A-7-5(18)	0	6	35	59	65	40	25	29
79	732+30	42lt	5-6	si cl	A-6(10)	1	10	58	31	37	21	16	20
			8-9	clay	A-7-6(14)	1	26	34	39	42	18	24	16
80	755+00	100lt	9-10.5	si l	A-4(8)	0	6	85	9	26	16	10	12
			28.5-30	loam	A-4(8)	5	38	41	16	25	21	4	20
			38.5-40	si cl	A-6(11)	1	4	64	31	38	20	18	18
81	759+00	42rt	17.5-19	si l	A-4(8)	1	31	51	17	20	16	4	16
82	813+75	70rt	6-8	clay (shaly)	A-6(8)	3	43	23	31	35	16	19	17
83	830+00	42lt	5-7	clay	A-7-6(12)	26	32	18	24	50	23	27	21
84	833+50	42rt	0.5-5.5	cl l	A-4(4)	12	40	28	20	27	18	9	19
85	835+00	42lt	6-8	clay (shaly)	A-7-6(14)	0	5	40	55	45	22	23	16
86	837+75	70rt	2-4	si cl l	A-6(12)	2	22	49	27	39	19	20	20
87	840+75	70rt	2-4	si cl	A-7-6(16)	3	12	52	33	45	18	27	16
88	844+00	70rt	4-6	clay (shaly)	A-7-5(20)	0	3	18	79	85	37	48	23

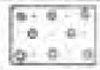
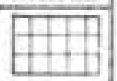
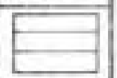
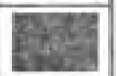
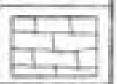
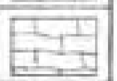
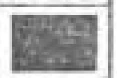
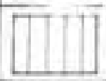
Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
89	875+10	42rt	15-17	clay (shaly)	A-7-6(14)	3	12	46	39	42	19	23	20
90	41+00	281t	4.0-6.0	si cl l	A-6(10)	0	3	70	27	34	19	15	19
91	51+00	15rt	4.0-6.0	clay	A-7-6(18)	5	12	39	44	51	21	30	20
92	232+00	10rt	12.0-14.0	loam	A-4(5)	11	41	39	9	NP	NP	NP	NP
93	42+50	13rt	10.0-12.0	clay (shaly)	A-7-6(15)	11	20	20	49	50	28	22	20
94	258+75	401t	0.5-2.0	si cl	A-7-6(12)	0	7	62	31	42	23	19	19
95	260+60		17.0-18.5	clay (shaly)	A-7-6(20)	3	13	26	58	66	27	39	20
96	308+00		0.0-1.0	si l	A-4(8)	0	4	78	18	32	22	10	23
97	342+00		2.0-4.0	si cl	A-7-6(13)	0	1	51	48	43	22	21	19
98	370+00		1.7-2.7	clay	A-7-6(19)	0	2	32	66	56	25	31	18
99	376+00		0.0-1.0	clay	A-7-6(13)	0	2	48	50	45	25	20	21
100	390+23	19rt	2.0-4.0	clay (shaly)	A-7-6(20)	0	1	31	68	60	25	35	17
101	414+50		1.0-3.0	clay (shaly)	A-7-6(19)	0	2	36	62	53	22	31	18
102	437+60	50rt	0.5-3.0	si cl l	A-4(8)	1	8	67	24	31	22	9	24
103	458+00		6.0-8.0	si cl	A-7-6(14)	1	6	58	35	45	22	23	22
104	465+00		2.5-5.0	si cl l	A-6(8)	4	8	64	24	33	22	11	23
105	473+50		4.5-6.0	si l	A-4(8)	1	4	78	17	31	24	7	25
106	484+50		2.0-3.0	clay (shaly)	A-7-6(19)	0	1	42	57	45	23	31	19
107	498+00		0.0-1.0	si cl	A-7-6(14)	0	1	51	48	47	26	21	21
108	508+00		0.0-1.0	si cl	A-7-6(16)	0	1	50	49	50	24	26	20
			5.0-6.0	clay	A-7-6(20)	0	1	34	65	58	24	34	18
109	541+00		2.0-4.0	si l	A-6(9)	24	23	39	14	32	19	13	21
			8.0-10.0	clay (shaly)	A-7-6(19)	0	1	37	62	55	23	32	19
110	62+23	24rt	2.5-4.0	silt loam	A-4(4)	0	7	74	19	25	19	6	
		24rt	15.0-16.5	sand	A-3(0)	0	92	0	8	NP	NP	NP	
		19rt	50-	si cl l(shaly)	A-4(5)	0	23	53	24	30	21	9	18
111	64+97	19rt	11.0-13.0	clay	A-6(11)	5	9	42	44	35	21	14	
	65+00	19rt	30.0-31.5	sand	A-1-b(0)	15	83	0	2	NP	NP	NP	
		19rt	88.0	si cl (shaly)	A-4(9)	0	6	58	36	31	21	10	18
		1351t	48.0-50.0	silt	A-4(0)	0	2	80	18	23	21	2	
112	69+50	1301t	7.0-9.0	clay	A-7-6(15)	1	7	33	59	46	20	26	
113	675+00	74rt	5.5-6.5	sand	A-3(0)	0	94.1	1.0	4.9	NP	NP	NP	26.0
114	682+00	161t	5.0-6.0	sandy cl l	A-6(4)	0	52.5	25.7	21.8	29.0	17.6	11.4	25.2
115	688+00	161t	1.0-2.0	sandy loam	A-4(1)	0	58.4	21.8	19.8	20.5	14.2	6.3	21.6
			3.0-3.6	cl l	A-6(9)	0	29.4	43.2	27.4	34.8	19.8	15.0	26.3
			4.0-4.7	loam	A-6(4)	0	42.6	38.6	18.8	30.2	19.7	10.5	24.1
			5.0-6.0	sand	A-3(0)	0	90.2	5.9	3.9	NP	NP	NP	23.2
116	712+00		0.2-0.8	loam	A-4(3)	0	48.5	35.7	15.3	19.6	15.4	4.2	26.8
			2.5-3.5	sa l	A-4(3)	0	52.5	29.7	17.8	23.0	15.0	8.0	25.6
			5.0-6.0	sa l	A-2-4(0)	0	70.6	17.6	11.8	16.0	14.3	1.7	21.5

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
117	728+00	74rt	0.2-0.6	cl 1	A-7-5(9)	0	36.1	39.2	24.7	47.4	33.0	14.4	48.5
			1.0-1.8	clay	A-4(6)	0	34.6	33.8	31.6	26.7	18.3	8.4	29.0
			4.0-5.0	cl 1	A-6(7)	0	28.7	41.6	29.7	28.6	17.7	10.9	24.8
118	758+00	74rt	0.1-0.8	si 1	A-4(8)	0	20.8	63.4	15.8	25.3	21.3	4.0	33.1
			1.5-2.3	clay	A-7-6(13)	0	12.8	46.0	41.2	45.7	24.6	21.1	30.0
			4.0-4.8	si cl 1	A-4(8)	0	14.7	63.7	21.6	30.0	20.5	9.5	28.8
119	782+00	74rt	0.0-2.9	sa 1	A-4(3)	0	51.0	35.3	13.7	33.3	23.8	9.5	30.0
			3.3-5.2	sa 1	A-4(2)	0	53.0	36.2	10.8	30.1	21.8	8.3	28.7
			6.3-9.4	sa 1	A-4(3)	0	51.0	43.1	5.9	27.7	21.5	6.2	28.8
120	804+50	74rt	0.0-1.7	loam	A-6(4)	0	48.5	33.7	17.8	36.3	23.4	12.9	31.7
			5.4-9.3	sa 1	A-4(3)	0	51.0	44.1	4.9	26.7	22.6	4.1	29.6
			14.0-15.7	sa cl 1	A-6(3)	0	58.3	16.5	25.2	34.2	17.6	16.6	23.2
121	824+00	74rt	0.5-4.5	sa 1	A-4(3)	0	51.0	40.2	8.8	29.8	23.2	6.6	28.0
			6.5-8.8	sa 1	A-4(0)	0	62.8	27.4	9.8	22.0	16.5	5.5	20.8
122	827+00	8.51t	5.0-6.0	clay	A-7-6(20)	0	8.1	14.1	77.8	58.5	26.6	31.9	14.5
123	840+00	8.51t	1.0-2.5	sand	A-2-4(0)	0	84.2	97.9	7.9	16.5	14.4	2.1	26.4
124	106+80		0.5-1.0	si cl 1	A-4(8)	0	1.9	77.6	20.5	35.5	28.2	7.3	26.62
			2.2-2.5	si cl 1	A-6(8)	0	4.9	70.4	24.7	37.1	26.3	10.8	22.70
			3.7-4.1	si cl 1	A-4(8)	0	4.6	72.4	23.0	34.5	24.8	9.7	20.73
			5.1-5.5	si cl 1	A-6(10)	0	4.7	71.3	24.0	32.9	18.9	14.0	17.13
125	109+80		0.0-0.5	silt	A-4(8)	0	2.9	82.3	14.8	25.0	17.0	8.0	18.44
			2.8-3.0	clay loam	A-4(8)	1.4	26.1	47.0	25.5	27.9	18.3	9.6	20.16
			11.5-12.0	si 1	A-4(8)	0	2.5	79.9	17.6	25.5	20.9	4.6	18.76
126	114+85	51t	0.5-0.8	si cl 1	A-4(8)	0	3.2	75.8	21.0	38.0	28.5	9.5	21.86
127	122+00		2.2-2.3	si cl 1	A-6(11)	0.4	4.0	66.5	19.1	40.5	22.3	18.2	14.54
128	138+10	15rt	4.2-4.4	si cl 1	A-6(12)	0	17.4	58.3	24.3	39.0	18.0	21.0	17.25
129	141+20	121t	7.4-7.6	clay	A-6(8)	0.1	1.6	46.3	52.0	35.0	24.1	10.9	19.34
130	147+50	51t	0.2-0.8	si cl	A-7-6(14)	0	3.5	53.7	42.8	50.1	29.7	20.4	13.49
131	153+60		4.9-5.1	si cl	A-7-6(17)	0	2.2	51.7	46.1	51.4	24.0	27.4	13.91
132	163+80		0.3-0.5	si cl	A-6(8)	0	5.6	61.4	33.0	40.2	29.5	10.7	18.21
			3.9-4.1	clay	A-7-6(19)	0	2.3	48.1	49.6	56.4	25.0	31.4	16.10
			5.6-5.8	si cl 1	A-7-6(12)	0	8.8	63.9	27.3	42.0	23.0	19.0	18.74
133	184+25		4.9-5.1	clay	A-6(10)	0.5	2.7	47.5	49.3	37.9	23.2	14.7	18.24
134	210+00		1.3-1.5	clay	A-7-6(17)	0	1.5	49.5	49.0	50.9	23.7	27.2	4.20
			2.1-2.3	clay	A-7-6(16)	0	1.4	46.0	52.6	47.5	22.0	25.5	6.01
			4.6-4.8	si cl	A-4(8)	0	2.1	56.1	41.8	34.0	26.7	7.3	16.06
135	258+30		1.5-1.7	clay	A-7-6(16)	0	1.1	37.1	61.8	48.2	22.1	26.1	3.95
			2.7-2.9	clay	A-7-6(15)	0	1.1	40.4	58.5	45.9	25.7	20.2	10.97
136	281+20		4.7-4.9	si cl	A-6(12)	0	2.1	57.9	40.0	38.0	18.4	19.6	19.04
137	288+00		0.8-1.0	si cl	A-6(12)	0	1.5	57.0	41.5	38.0	17.8	20.2	15.14

Site	Station	Offset (ft.)	Depth (ft.)	AASHTO Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
138	292+00		0.0-0.4	si cl	A-4(8)	0	3.1	65.0	31.9	30.0	20.5	9.5	18.74
139	310+00		0.0-0.5	silty clay	A-4(8)		0.6	53.2	46.2	36.0	32.1	3.9	25.00
			2.0-2.2	clay	A-7-5(20)		0.4	37.8	61.8	60.8	30.0	30.8	13.13
			4.7-4.8	clay	A-6(11)	0	1.0	48.0	51.0	40.0	22.8	17.2	14.25
140	315+00		0.8-1.0	clay	A-7-6(14)	0	2.7	48.3	49.0	42.0	17.0	25.0	12.94
141	339+50	201t	1.0-1.5	clay	A-7-6(19)	10.8	12.7	39.0	37.5	53.2	21.6	31.6	19.47
			2.3-2.5	clay	A-7-6(18)	0	1.8	46.2	52.0	53.0	23.7	29.3	18.58
142	362+35		1.6-1.8	clay	A-7-6(19)	0	1.0	36.0	63.0	55.9	24.8	31.1	11.67
143	372+00		3.1-3.2	clay	A-7-6(19)	0	1.2	35.3	63.5	53.9	22.6	31.3	15.99
			5.3-5.5	clay	A-7-6(15)	0	3.7	41.3	55.0	44.1	18.6	25.5	16.79
144	381+00		0.0-0.5	clay	A-6(11)	2.1	4.6	43.8	50.5	39.0	20.6	18.4	19.42
145	405+00		0.9-1.1	clay	A-7-6(16)	0	1.0	36.0	63.0	49.0	24.5	24.5	22.80
			2.5-2.7	clay	A-7-6(18)	0	0.7	28.1	71.2	50.0	20.3	29.7	26.43
146	431+00		1.2-1.5	clay	A-7-6(20)	0	0.6	29.8	69.6	62.6	26.6	36.0	18.87
147	438+00		5.7-5.9	clay	A-7-6(19)	0	1.1	39.9	59.0	55.0	20.9	34.1	14.57
148	447+00		0.2-0.5	si cl 1	A-6(8)	0	4.5	67.5	28.0	30.5	18.9	11.6	13.47
149	469+80		1.0-1.5	si cl 1	A-4(8)	0	2.8	72.6	24.6	29.1	22.0	7.1	25.00
			3.2-3.8	si cl	A-4(8)	0	2.2	66.8	31.0	28.9	19.0	9.9	18.60
150	488+00		6.0-6.5	clay	A-7-6(16)	1.6	9.4	40.7	48.3	46.5	18.8	27.7	17.73
			9.5-10.0	cl 1	A-6(9)	7.7	24.8	43.4	25.1	35.1	21.6	13.5	14.34
			12.0-12.5	clay	A-7-5(18)	0	3.6	23.4	73.0	71.3	46.5	24.8	21.65
151	500+40		0.5-1.0	si 1	A-4(8)	0	5.1	76.9	18.0	36.6	22.5	14.1	27.62
			2.0-2.5	si 1	A-4(8)	0.5	4.6	79.4	16.0	33.3	27.2	6.1	26.04
152	504+60		7.0-7.5	si 1	A-4(8)	4.1	17.6	63.5	14.8	24.9	18.5	6.4	23.54
			8.3-8.5	si cl 1	A-6(9)	2.6	12.7	63.5	21.2	30.9	17.9	13.0	16.37
153	506+50		1.0-1.5	si cl	A-7-6(15)	0	0.9	58.1	41.0	45.5	21.7	23.8	15.20
154	510+00		5.5-5.8	si cl	A-7-6(11)	0	2.0	58.9	39.1	41.3	23.4	17.9	17.53
155	514+50		1.0-1.5	clay	A-7-6(18)	0	1.0	48.9	50.1	55.2	26.8	28.4	15.99
			4.5-4.8	clay	A-7-6(17)	0	1.1	43.7	55.2	51.6	23.9	27.7	14.31
156	524+45		1.0-1.5	si cl	A-4(8)	0	1.1	65.3	33.6	39.6	29.2	10.4	21.27
			4.0-4.5	clay	A-7-6(20)	0.2	2.7	46.4	50.7	66.1	24.1	42.0	15.45
157	535+00		2.0-2.5	si cl 1	A-4(8)	0	3.1	67.1	29.8	36.0	26.8	9.2	23.84
158	552+00		0.0-0.5	si cl	A-4(8)	0	3.1	53.5	43.4	38.6	29.7	8.9	19.27
			2.0-2.5	si cl	A-4(8)	0	2.7	55.5	41.8	39.2	30.7	8.5	20.42
159	565+50		5.5-6.0	si cl 1	A-6(10)	0	0.8	70.2	29.0	35.2	19.8	15.4	18.07

APPENDIX C

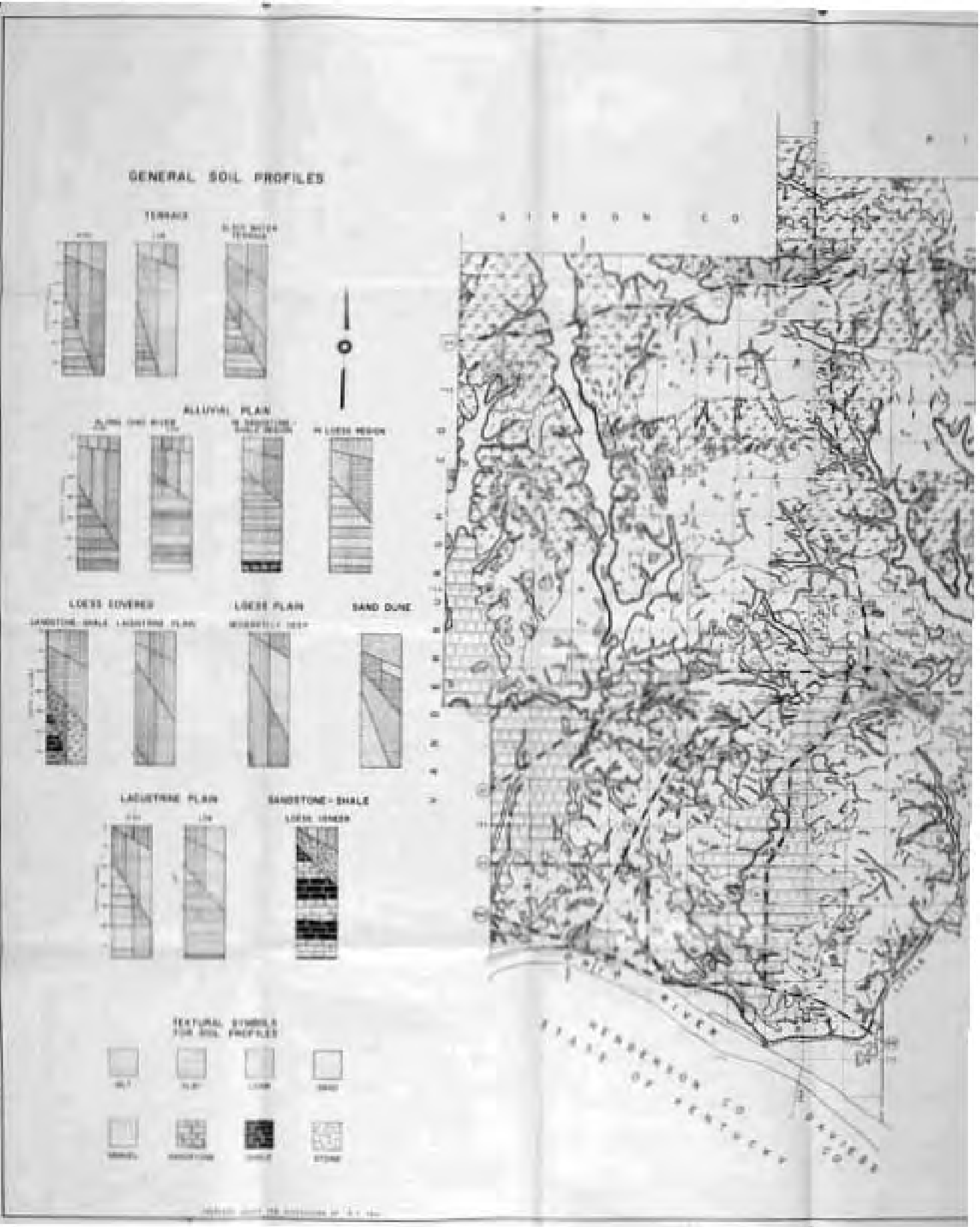
SOIL CLASSIFICATION AND PROFILE SYMBOLS

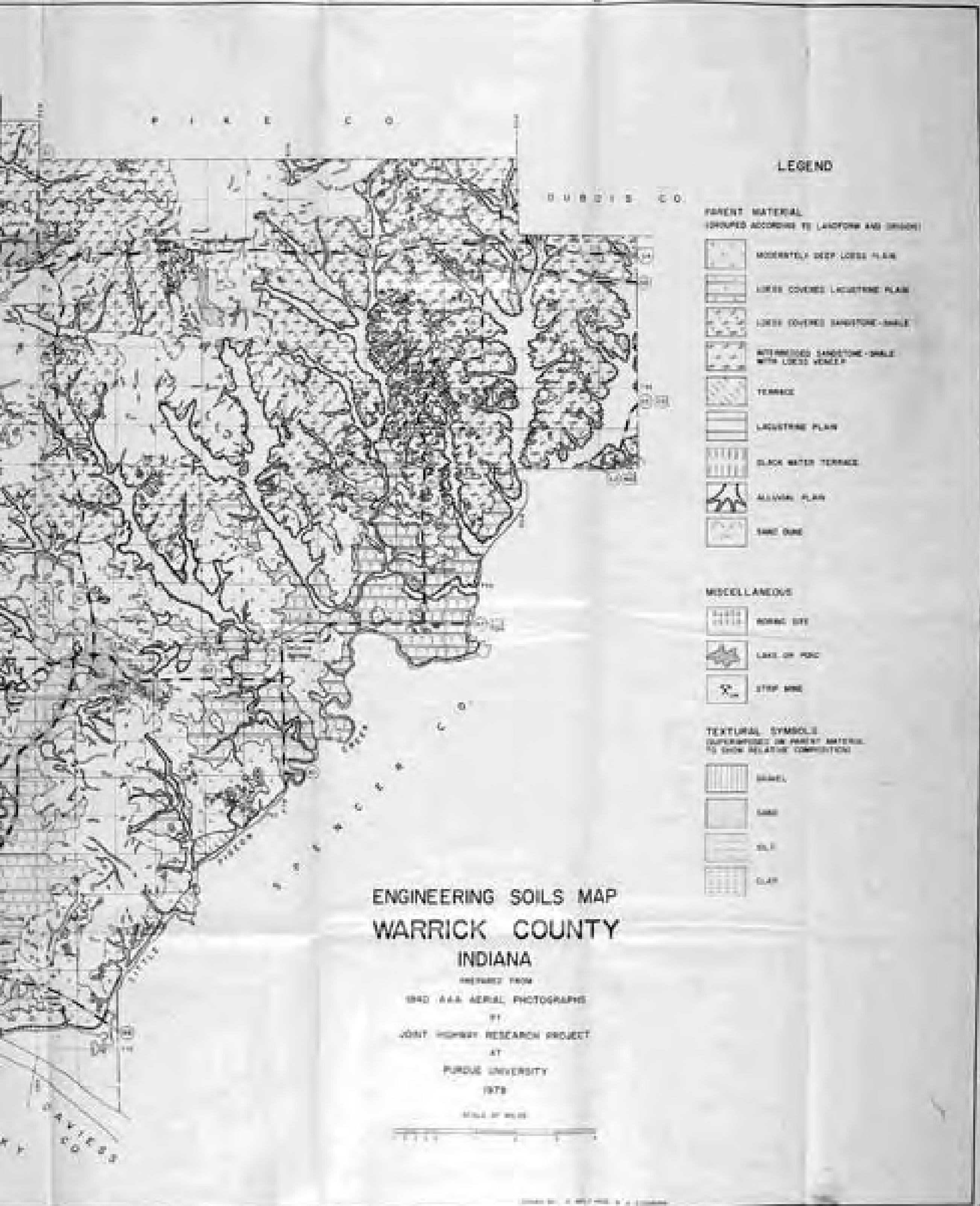
Description	Grain Size Distribution: Gravel % Retained on #10	Sand #10-#200	Silt 0.05-0.005mm	Clay Less than 0.005mm	Plastic Index	Symbol
Gravel	85-100	0-15	0-10	0-10	NP	
Sandy Gravel	50-85	15-50	0-10	0-10	6 Max.	
Sand	0-15	85-100	0-10	0-10	NP	
Gravelly Sand	20-49	45-85	0-10	0-10	6 Max.	
Sandy Loam	0-19	50-80	0-50	0-20	6 Max.	
Sandy Clay Loam	0-19	50-80	0-30	20-30	10 Max.	
Sandy Clay	0-19	55-70	0-15	30-45	11 Min.	
Loam	0-19	30-50	30-50	0-20	10 Max.	
Silt Loam	0-19	0-50	50-100	0-20	10 Max.	
Silty Clay Loam	0-19	0-30	70-100	20-30	11 Min.	
Silty Clay	0-19	0-15	55-70	30-45	11 Min.	
Clay Loam	0-19	20-50	50-80	20-30	11 Min.	
Clay	0-19	0-55	0-55	30-100	11 Min.	
Peat or Muck						
Limestone						
Sandstone						
Shale						
Stony Fragments						
Organic Matter						
Topsoil						

Classification of Gravelly Soils

85%-100% gravel plus finer material - Gravel
50%-84% gravel plus finer material - Clayey, silty or sandy gravel
20%-49% gravel plus finer material - Use fine classification and called gravelly sand, gravelly silt or gravelly clay
0%-19% gravel plus finer material - Use fine classification only

IN/JHRP-79/20


GENERAL SOIL PROFILES
TERRACE
ALLUVIAL PLAIN
LOESS COVERED
SANDSTONE-SHALE LACUSTRINE PLAIN
LOESS PLAIN
SAND DUNE
LACUSTRINE PLAIN
SANDSTONE - SHALE
TEXTURAL SYMBOLS
FOR SOIL PROFILES
SILT
CLAY
LOAM
SAND
GRAVEL
SANDSTONE
SHALE
STONE
GIBSON CO
OHIO RIVER
HENDERSON CO
DAVIESS CO
STATE OF KENTUCKY


ENGINEERING SOILS MAP
WARRICK COUNTY
INDIANA
PREPARED FROM
1940 A.A.A. AERIAL PHOTOGRAPHS
BY
JOINT HIGHWAY RESEARCH PROJECT
AT
PURDUE UNIVERSITY
1979
SCALE OF MILES
LEGEND
PARENT MATERIAL
(GROUPED ACCORDING TO LANDFORM AND ORIGIN)
MODERATELY DEEP LOESS PLAIN
LOESS COVERED LACUSTRINE PLAIN
LOESS COVERED SANDSTONE-SHALE
INTERBEDDED SANDSTONE-SHALE WITH LOESS VENEER
TERRACE
LACUSTRINE PLAIN
BLACK WATER TERRACE
ALLUVIAL PLAIN
SAND DUNE
MISCELLANEOUS
BORING SITE
LAKE OR POND
STRIP MINE
TEXTURAL SYMBOLS
(SUPERIMPOSED ON PARENT MATERIAL TO SHOW RELATIVE COMPOSITION)
GRAVEL
SAND
SILT
CLAY
PIKE CO.
DUBOIS CO.
SPENCER CO.
DAVIESS CO.